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Devonian Brachiopods

of

New Mexico

by

G. Arthur Cooper

and

J. Thomas Dutro, Jr.

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1259 Trumansburg Road
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DEVONIAN BRACHIOPODS OF NEW MEXICO

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ABSTRACT

The Devonian of New Mexico consists of six formations: the late Middle Devonian Oñate Formation; the early Late Devonian (Frasnian–Chemungian) Sly Gap Formation and Contadero Formation; the early Famennian (Cassadagan) Thoroughgood Formation and Rhodes Canyon Formation; and the middle Famennian (Cassadagan–early Conewangoan) Percha Formation. The Oñate and Sly Gap formations are found in the Sacramento, San Andres and Caballo Mountains, the Derry Hills and Mud Springs Mountains and westward to Hermosa in the Black Range, south and west of which they disappear. The Contadero, Thoroughgood and Rhodes Canyon formations are confined to a small part of the San Andres Mountains.

The Percha Formation consists of two members: the Ready Pay Member of black shale below; and the Box Member above, a somewhat calcareous and cobbly shale replete with fossils. The Percha Formation appears near Hillsboro in the Black Range, south of Hermosa, and extends westward to Santa Rita and Silver City and south to Cooks Peak, north of Deming.

The Oñate Formation at the eastern and western ends of its exposure is composed mostly of carbonate rocks; but, in the Caballo Mountains, Derry Hills and Mud Springs Mountains, it is composed mainly of fossiliferous calcareous shale. The Sly Gap Formation is predominantly shaly and usually cobbly; except for color and fauna, it resembles the Box Member of the Percha Formation and is often confused with it. The Contadero, Thoroughgood and Rhodes Canyon formations are, respectively, silty shale, sandstone and sandy shale.

The fauna of the late Middle Devonian Oñate Formation contains a species of *Rhysochonetes* Johnson (1970) and two species of *Warrenella* Crickmay (1953) in an assemblage of 34 genera (two new) and 42 species. The Sly Gap fauna is extensive, consisting of 66 species (27 new) in 38 genera (one new). Distinctive in the Sly Gap fauna are: *Douvillinaria* Stainbrook (1945), *Calvinaria* Stainbrook (1945), *Thomasaria* Stainbrook (1945), *Hypothyridina* Buckman (1906) and the ammonoid *Manticoceras* Hyatt (1884). The Contadero fauna with *Ripidiorhynchus* Sartenaer (1966b) is more modest, consisting of 24 species (nine new) in 20 genera (two new). The Thoroughgood fauna, with a new species of *Camarotoechia* (ss) Hall (1893), consists of 12 species (three new) in 10 genera (two new). The fauna of the Rhodes Canyon Formation numbers 16 species (four new) and 12 genera (including *Crinisarina* new genus, present in both the Thoroughgood and Rhodes Canyon formations).

The Ready Pay Member of the Famennian Percha Formation has few brachiopods and those only at top and bottom, non-diagnostic and poorly preserved. The Box Member, on the other hand, is extremely rich in fossils and has corals, bryozoans, some bivalves and gastropods, the ammonoid *Falciclymenia* Schindewolf (1923) as well as numerous brachiopods. Thirty brachiopod genera (three new) have been identified in 44 species, of which 13 are new. Important genera are: *Paurorhynchina* Cooper (1942), *Syringospira* Kindle (1909), and *Cyrtiorina* new genus.

Correlation based on brachiopods, buttressed by conodont and ammonoid information where available, is indicated on correlation charts. It is clearly shown that the entire Percha Formation is of Famennian age and that the Sly Gap Formation is older and is not correlative to any part of the Percha.

Eleven new genera and 85 new species are described in this paper. The new genera are: *Dichacaenia*, *Morphorhynchus*, *Acutoria*, *Floweria*, *Stainbrookia*, *Colophragma*, *Crinisarina*, *Petasmaria*, *Cyrtiorina*, *Hispidaria* and *Oiosia*. The new species and subspecies are: *Lingulipora porifera*, *Aulacella elliptica*, *Stainbrookia rotunda*, *Cariniferella alleni*, *C. costellata*, *Thiemella platys*, *T. quadrata*, *Tropidoleptus platys*, *Strophodonta umbonata*, *Strophonelloides dorsoconvexus*, *S. parvulus*, *Nervostrophia extensa*, *N. geniculata*, *N. mucrospina*, *N. plana*, *N. solida*, *Douvillina contaderoensis*, *D. minuta*, *D. parviuscula*, *D. rectangularata*, *Douvillinaria diversa*, *Floweria transversalis*, *F. magnacatrix*, *Schuchertella resupinata*, *Striatochonetes nanus*, *S. subcarinatus*, *Retichonetes obscurus*, *R. perchaensis*, *Rhysochonetes johnsoni*, *Eostrophalosia inexpectata*, *Dichacaenia perplexa*, *D. umbonata*, *Leioproductus pauperculus*, *Devonoproductus intermedius*, *Gypidula bowsheri*, *G. mimica*, *G. stainbrookii*, *G. subcarinata*, *Cupularostrum? stvensoni*, *Ripidiorhynchus newmexicoense*, *Morphorhynchus varicostatum*, *Hypothyridina emmonsii rotunda*, *Hadrhorhynchia alta*, *H. mclareni*, *Coeloterorhynchus magnificum*, *Colophragma ellipticum*, *Trifidorostellum obscurum*, *Camarotoechia latissinuata*, *Leiorhynchus sphaericum*, *Platyterorhynchus obscurum*, *Petasmaria compacta*, *P. multicostrata*, *P. patens*, *Atryparia rubra*, *Desquamatia costata*, *Costatrypa extensa*, *Iowatrypa rara*, *Spinatrypa compacta*, *S. obsolescens*, *S. trulla decorticata*, *Crinisarina reticulata*, *Ambocoelia capillata*, *Echinocoelia pretiosa*, *Eleutherokomma extensa*, *Mucrospirifer parvus*, *Tylothyris compacta*, *T. sulcocostrata*, *Acutoria angulata*, *Acutatheca prolifica*, *Thomasaria demissa*, *T. warreni*, *Cyrtospirifer arenarius*, *C. convexus*, *C. pyramidalis*, *C. rotundus*, *Hispidaria posterogranulosa*, *H. spinosa*, *Uchtospirifer? rarus*, *Indospirifer anomala*, *I. exfoliata*, *Warrenella magna*, *W. floweri*, *Elita magister*, *Cyrtina variabilis*, *Afilasma inexpectatum*.

INTRODUCTION

PURPOSE AND SCOPE

The geologic history of the Devonian of New Mexico is developed from analysis of the strata and fossils, with special emphasis on the systematic description of the brachiopods. Devonian rocks are widely distributed in the south-central and southwestern parts of the state, especially in the Sacramento, San Andres, and Caballo Mountains (Text-figs. 1, 2, 3). Other critical exposures are in the Black Range, Derry Hills, Mud Springs Mountains, and Cooks Peak area. Detailed stratigraphic sections and biostratigraphic data are presented, from which correlations, facies distributions, and paleogeographic conclusions are drawn. A faunal zonation, based primarily on brachiopods, is given and its age significance is discussed. This is supported by evidence based on occurrences of conodonts, corals and cephalopods.

GEOGRAPHIC DISTRIBUTION

Devonian rocks are thin over most of New Mexico, ranging up to about 100 m in the thickest sections. Most sections, however, are less than 30 m (100 ft) thick. This fact led most early workers, who were mainly concerned with geologic mapping, to place all Devonian rocks in a single formation—the Percha Shale (Cooper *et al.*, 1942). However, this thin sequence contains a variety of lithic facies and faunas and is now known to range in age from late Middle Devonian to mid-Famennian. Full appreciation of these complexities has come slowly as data accumulated over

the past 25 years, but the present state of knowledge permits a detailed synthesis that places the Devonian of New Mexico in modern perspective.

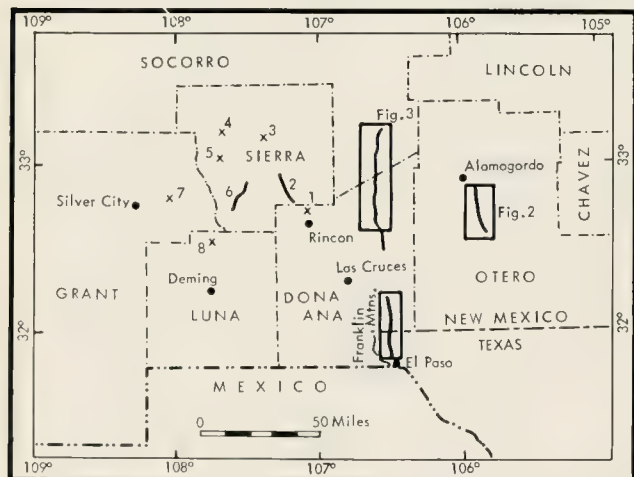
Despite statements to the contrary in earlier papers, several distinct rock units can be recognized in the sequence, and each contains one or more distinct faunas. The oldest unit, the Oñate Formation, crops out mainly in the San Andres and Sacramento Mountains (Text-figs. 4, 5), although it is also exposed in the Caballo Mountains, the Derry Hills, and in the Mud Springs Mountains west of Truth-or-Consequences. A critical locality for regional interpretation of the Oñate is near Hermosa, the westernmost outcrop in which the Oñate has been recognized. A southern and south-eastern facies of the Oñate is the Canutillo Formation of the Franklin Mountains in west Texas.

The Sly Gap Formation overlies the Oñate in most places, although it is missing in the Caballo Mountains and in the southernmost sections of the Sacramento Mountains. This discontinuity may be due to a period of late Devonian erosion. In the central part of the San Andres Mountains, the Sly Gap is overlain by the Contadero Formation, which does not occur elsewhere. Still more limited in extent are the post-Contadero units, the Thoroughgood and Rhodes Canyon formations, which are restricted to a small area in the San Andres Mountains.

The Percha Formation, widely exposed in the Black Range between Hillsboro and Silver City, extends south to the Cooks Peak area and beyond. This unit is divided into a lower black shale (the Ready Pay, or Silver*, Member) and an upper shaly nodular limestone (the Box, or Bella*, Member). Relationship of the Percha to older Devonian units is displayed near Hermosa where the Ready Pay Member unconformably overlies the Sly Gap Formation which, in turn, succeeds the Oñate Formation in normal stratigraphic sequence (Text-fig. 6). Although occurrences east of Hillsboro are recorded in the literature, we found no exposures of the Box Member of the Percha in the ranges east of that place; the occurrence so designated, Derry Hills, proved to be of Pennsylvanian age.

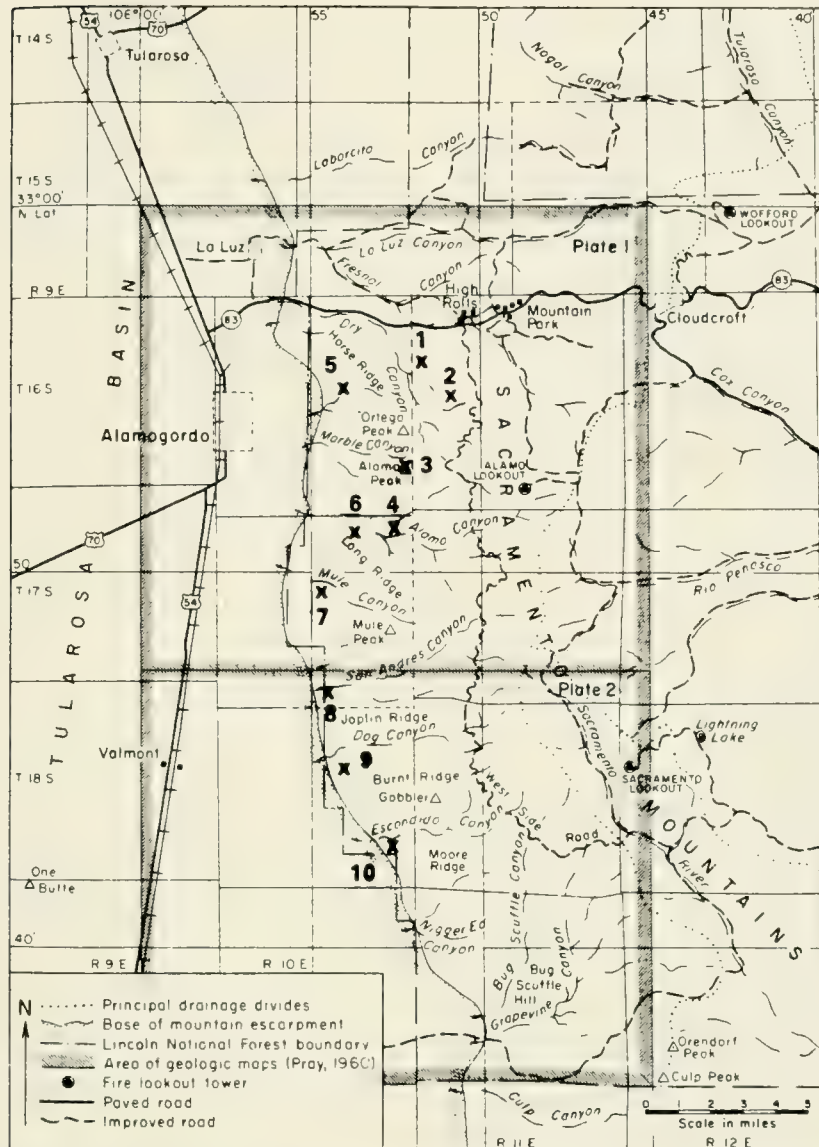
NATURE OF OUTCROPS

The Devonian strata are predominantly shaly and occur as partly covered slopes between more resistant formations above and below. Debris from overlying units commonly covers the shaly slopes, and complete sections of the Devonian are hard to find. Good out-



Text-figure 1.—Index map of south-central New Mexico, showing major outcrop areas of Devonian rocks; location of Figures 2 and 3; 1, Rincon; 2, southern Caballo Mountains; 3, Mud Springs Mountains; 4, Hermosa; 5, Chise; 6, Hillsboro area; 7, Silver City area; 8, Cooks Range.

* The Silver and Bella members are terms proposed by C. R. Keyes (1908); although prior in publication to Stevenson's (1945) names, they have not received acceptance because of poor definition and poor type sections.



Text-figure 2.—Map of a part of the Sacramento Mountains, showing location of measured sections of Oñate Formation, Sly Gap Formation, and related strata. 1, Pig Canyon anticline; 2, Arcente Canyon; 3, Alamo Peak; 4, Alamo Canyon; 5, Indian Wells Canyon; 6, Deadman Canyon; 7, Mule Canyon; 8, San Andres Canyon; 9, Dog Canyon; 10, Escondido Canyon. Base map is from Pray, 1961, figure 2.

crops occur in the canyons of the San Andres and Sacramento Mountains, but care must be taken in assigning a stratigraphic position to fossils collected, because these migrate downslope from bedrock exposures.

ACKNOWLEDGMENTS

Although C. C. Branson is now deceased, it is still fitting to acknowledge our obligations to him for acquainting Cooper with the geology and geography of the Devonian of New Mexico and for the collections he presented to the National Museum of Natural History. We recall our work with A. L. Bowsher, later

with the U.S. Geological Survey, with great pleasure. We also acknowledge the help of W. T. Allen who assisted Bowsher in the field.

Our special thanks go to R. Flower, New Mexico Bureau of Mines and Mineral Resources, for help in the field and for the loan of his useful Devonian collections. We thank the officers of the White Sands Proving Ground for permission to examine sections in the San Andres Mountains. The many roads bulldozed into the poorly accessible parts of the range proved a boon to our efforts.

We are greatly indebted to F. V. Stevenson, of Mountain Home, Arkansas, for the extensive collec-

tion of New Mexico Devonian fossils he presented to the Smithsonian Institution in 1947.

We appreciate the careful reviews of the manuscript by A. J. Boucot, J. G. Johnson and G. Klapper. Helpful suggestions on brachiopod systematics by Boucot and Johnson, and on conodont ages and correlations by Klapper and A. G. Harris, are gratefully acknowledged. P. Sartenaer also provided comments on the brachiopod taxonomy, which we deeply appreciate. However, the final decisions on the taxonomy, age designations and correlations are our own and do not always agree with the views of the reviewers.

Finally, we thank T. Lierman for his superb drafting of the text-figures, N. P. Dutro for her suggestions on illustration design and an indefatigable dedication to production of the index, and P. R. Hoover for innumerable editorial suggestions that greatly improved the final product.

PREVIOUS WORK

Geologic work in the Devonian of New Mexico in the early part of this century was concentrated on the black shales in the southwestern part of the state. These strata were named the Percha Shale by Gordon (1907) and were later (Paige, 1916) described in the Silver City area. Formal member names were proposed by Stevenson (1945) who called the "lower Percha shale" the Ready Pay Member and the "upper Percha shale" the Box Member. Stevenson also established the stratigraphic framework for distinguishing other Devonian units in south-central New Mexico and named the Sly Gap Formation (Stevenson, 1941b) and the Oñate and Contadero formations (Stevenson, 1945). A good summary of work on the Devonian of New Mexico up to the mid-1940's is given in Stevenson (1945).

Prior to Stevenson's studies, Darton (1917, p. 44-46) described Devonian strata in the various ranges from Cooks Range to the Sacramento Mountains. The strata, regardless of lithology and fossil content, were called Percha Shale. However, he noted that "The beds in the San Andres Mountains appear to carry a smaller number of the typical lower Ouray Percha forms than are present in Lake Valley, and more of the forms characteristic of the Martin, Hackberry and Nevada limestone."

In a short paper describing the fauna and correlation of the Sly Gap Formation, M. A. Stainbrook (1948) compared that assemblage with the Independence Shale fauna of Iowa, which he had recently described (Stainbrook, 1945). Several sections of the Upper Devonian strata were graphically presented and briefly described in two excellent papers on the Mississippian of southwestern New Mexico (Laudon and Bowsher, 1941; 1949).

Three regional monographs of large areas in southern New Mexico give many details of Devonian stratigraphy and geologic history. In a paper on the geology of the Caballo Mountains by Kelly and Silver (1952), the Devonian shales are discussed as Percha Formation. However, the sequence at Haystack Canyon is considered of Sly Gap age and Stevenson is quoted (1945) as assigning the beds in the Mud Springs Mountains and Caballo Mountains to the Sly Gap Formation. The exposures at Nackaye Mines were overlooked by Kelly and Silver.

Several detailed sections are presented by Kottowski *et al.* (1956) in their stratigraphic study of the San Andres Mountains. With some modification and correction, the stratigraphic data on the Devonian of the Rhodes Canyon, Hembrillo Canyon and Ash Canyon areas are used as a basis for our biostratigraphic analysis.

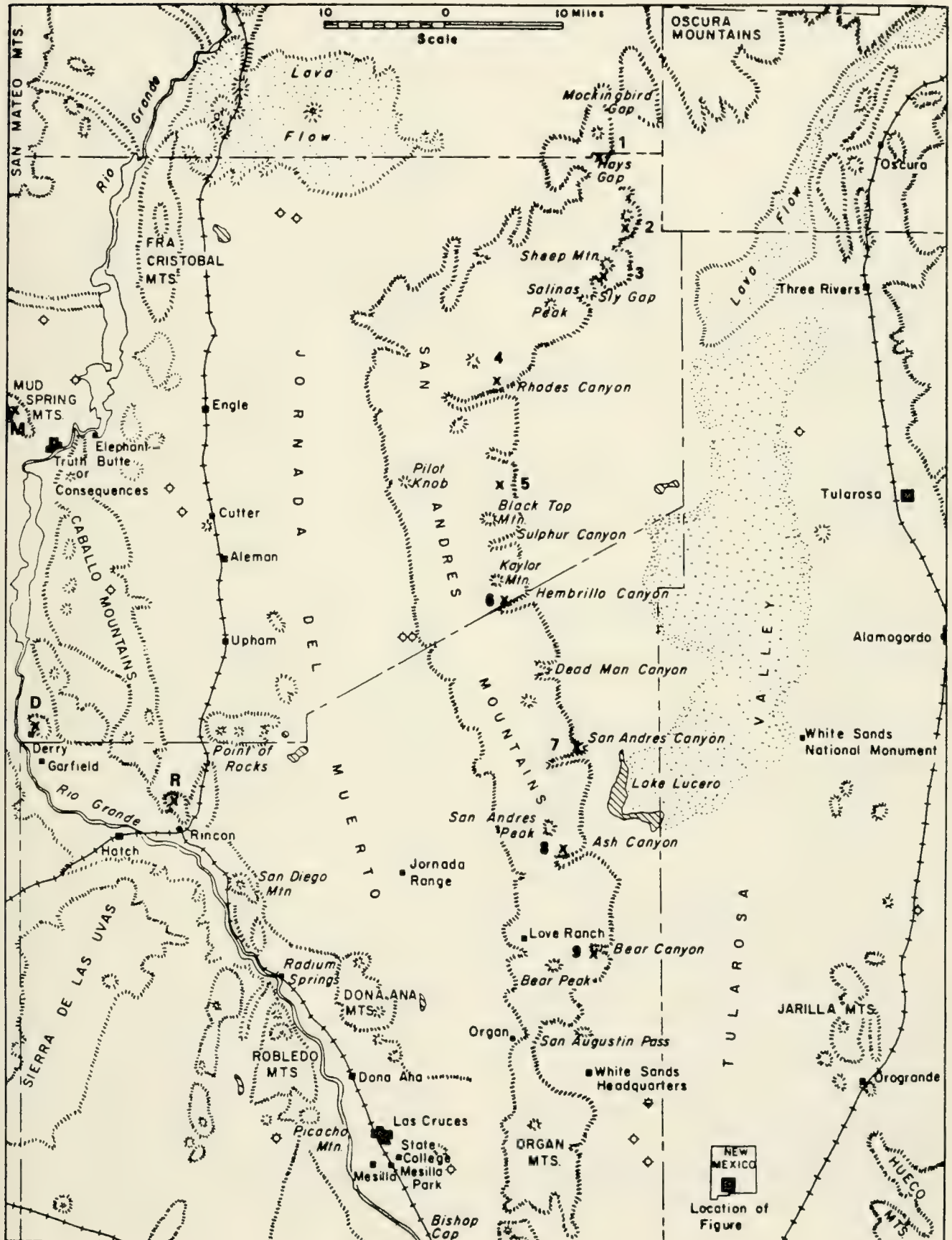
In his paper on the geology of the Sacramento Mountains escarpment, Pray (1961) gives some additional details on the Devonian formations, especially the Oñate Formation. He also discusses the problem of the black shales, in certain local areas. He assigns these black sediments to the Percha Shale. Pray's mapping is invaluable for locating critical Devonian sections in the Sacramento Mountains.

Jicha (1954) mapped the Percha Formation in the Lake Valley quadrangle; and Zeller (1965) discusses Devonian formations in the Big Hatchet Mountains area.

Several papers by Flower (1958, 1959, 1965, 1970) elucidate the early Paleozoic and Devonian in New Mexico. Flower (1959) redefined the Contadero Formation and named two new post-Contadero formations in the central San Andres Mountains. He showed that the Thoroughgood Formation overlies the Sly Gap in the central San Andres area and proposed the Rhodes Canyon Formation to describe about 23 m (75 ft) of beds above the Thoroughgood in the Rhodes Canyon section.

Bowsher (1967) summarized all earlier published work, and included data from field work accomplished in company of L. R. Laudon, and by the present authors, in a general paper on the Devonian System in New Mexico.

Text-figure 3.—Map of the San Andres Mountains, showing locations of measured sections of Devonian and related strata. 1, Johnson Park; 2, Capital Peak; 3, Sheep Mountain; 4, Rhodes Canyon; 5, Ash Canyon (north); 6, Hembrillo Canyon; 7, San Andres Canyon; 8, Ash Canyon (south); 9, Bear Canyon. Localities west of San Andres Mountains: R = Rincon; D = Derry; M = Mud Springs Mountains. (from Kottowski *et al.*, 1956, fig. 1.)



OÑATE FORMATION (Pl. A)

TYPE SECTION AND GENERAL STRATIGRAPHY

The type section of the Oñate Formation, named by Stevenson (1945), is in San Andres Canyon in the San Andres Mountains (loc. 523s). The formation consists predominantly of ferruginous dolomitic siltstone, shale and limestone and is about 27 m (90 ft) thick in the type area. Several thickness measurements, made in San Andres Canyon by various investigators, range from about 25 to 28 m (85 to 95 ft). The thickness of the Oñate is variable in the San Andres Mountains, and it thins both to the north and south of the type section.

In the Sacramento Mountains (Pl. A, figs. 1, 3), the Oñate is lithologically similar to its outcrops in the San Andres Mountains, and varies from about 6 to 18 m thick (20 to 60 ft). The thickest section is in Dog Canyon and the unit generally thins both to the north and south.

West of the San Andres Mountains, the Oñate is present in the southern Caballo Mountains, near Rincon. In the Derry Hills and the Mud Springs Mountains it is mostly shale. The Oñate has been recognized as far west as Hermosa where it is 7 m (23 ft) thick and is mostly limestone.

The Oñate Formation is regionally unconformable above various early Paleozoic formations (Text-fig. 7). In the southern San Andres and southern Sacramento Mountains, it lies on the Silurian Fusselman Dolomite. North of Hembrillo Canyon in the San Andres Mountains, the underlying units are the upper formations and members of the Montoya Group (late Ordovician). In the more western exposures, from Mud Springs Mountains to Hermosa, the Oñate again rests unconformably on the Fusselman Dolomite.

The Sly Gap Formation disconformably overlies the Oñate Formation except where the Sly Gap has been removed by late Devonian erosion. In the Sacramento Mountains, from Pig Canyon south to Mule Canyon, reddish-weathering, ferruginous, silty dolomite forms the uppermost beds of the Oñate. Basal beds of the Sly Gap consist of greenish to gray clay shale with scattered limestone nodules. South of Mule Canyon, the early Mississippian Caballero Formation rests unconformably on the Oñate. In the southern San Andres Mountains, the Oñate is overlain by a dominantly dark grey shale sequence that we assign to the Sly Gap.

FOSSIL CONTENT AND DISTRIBUTION

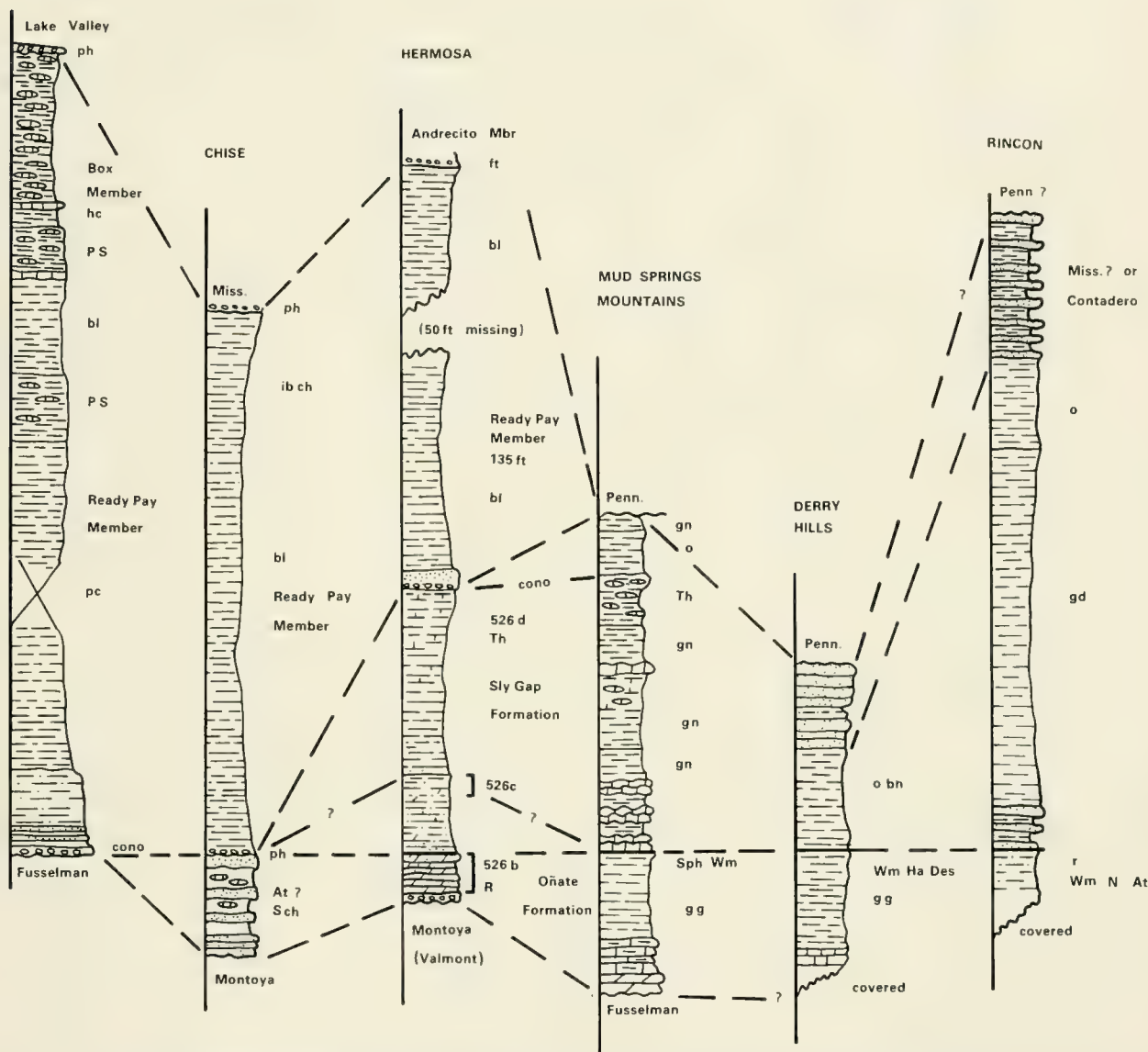
Fossils are widely, but sparsely, distributed in the Oñate throughout its area of outcrop. Although brachiopods are the most abundant faunal element, there are also many bryozoans (mainly *Cystodictya* Ulrich, 1882), a few tabulate corals (*Aulopora* Goldfuss, 1829), trace fossils (burrows and borings) and, in the Mud Springs Mountains (locs. 522f, 523i), the receptaculitid *Sphaerospongia* cf. *S. tessellata* (Phillips, 1841).

In the type section in San Andres Canyon in the San Andres Mountains, the lower 7 m (25 ft) contains abundant specimens of *Rhysochonetes* Johnson (1970) with a few individuals of *Echinocoelia* Cooper and Williams (1935) near the top. A large species of *Platyterorhynchus* Sartenaer (1970) is abundant in the overlying 2.4 m (8 ft) thick unit. The next higher bed (4 m, or 13 ft thick) contains abundant *Cystodictya*, along with *Platyterorhynchus*, *Nervostrophia* Caster (1939) and *Rhysochonetes*. The overlying unit, 2.7 m (9 ft) thick, has abundant bryozoans and the brachiopods *Schizophoria* King (1850), *Nervostrophia*, *Dichacaenia* n. gen. and *Atryparia* Copper (1966). In the upper part of the formation, 4.5 to 8 m (15 to 27 ft) below the top, large individuals of *Warrenella magna* n. sp. are present, and *Schizophoria* and *Desquamatia* Alekseeva (1960) are abundant. This sequence serves to tie together the Oñate of the western exposures with that of the Sacramento Mountains in that it includes the western *Warrenella* beds, not present in the Sacramentos, and the *Platyterorhynchus*-*Cystodictya* assemblage, common over the entire extent of Oñate exposures.

Typical of the Sacramento Mountains Oñate is the sequence at Alamo Peak where *Platyterorhynchus* and *Cystodictya* dominate the assemblage and no particular vertical zonation is evident. Other genera, common to the type section, are: *Schizophoria*, *Nervostrophia*, *Atryparia*, *Desquamatia* and *Echinocoelia*. Neither *Warrenella* nor *Rhysochonetes* was found in the Sacramentos. *Striatochonetes* Mikryukov (1968) apparently occupies a place in the Sacramento assemblage similar to that of *Rhysochonetes* in the western exposures.

The Mud Springs Mountains section is characteristic of the western part of the region. *Rhysochonetes* occurs commonly in the lower 3 m (10 ft). The overlying 6 m (20 ft) contains a varied assemblage, including *Schizophoria*, *Leiorhynchus* Hall (1860a), *Morphorhynchus* n. gen., *Atryparia*, *Desquamatia* and *Eleutherokomma* Crickmay (1950), in addition to *Sphaerospongia*. The uppermost 6 m (20 ft) contains the same brachiopods plus *Nervostrophia*, *Dicha-*

PERCHA
TYPE AREA
(composite)



Text-figure 6.—Correlated stratigraphic sections of Devonian rocks at selected localities west of the San Andres Mountains, New Mexico (See Text-figure 1 for location of sections and Text-figure 5 for explanations of abbreviations and lithic patterns).

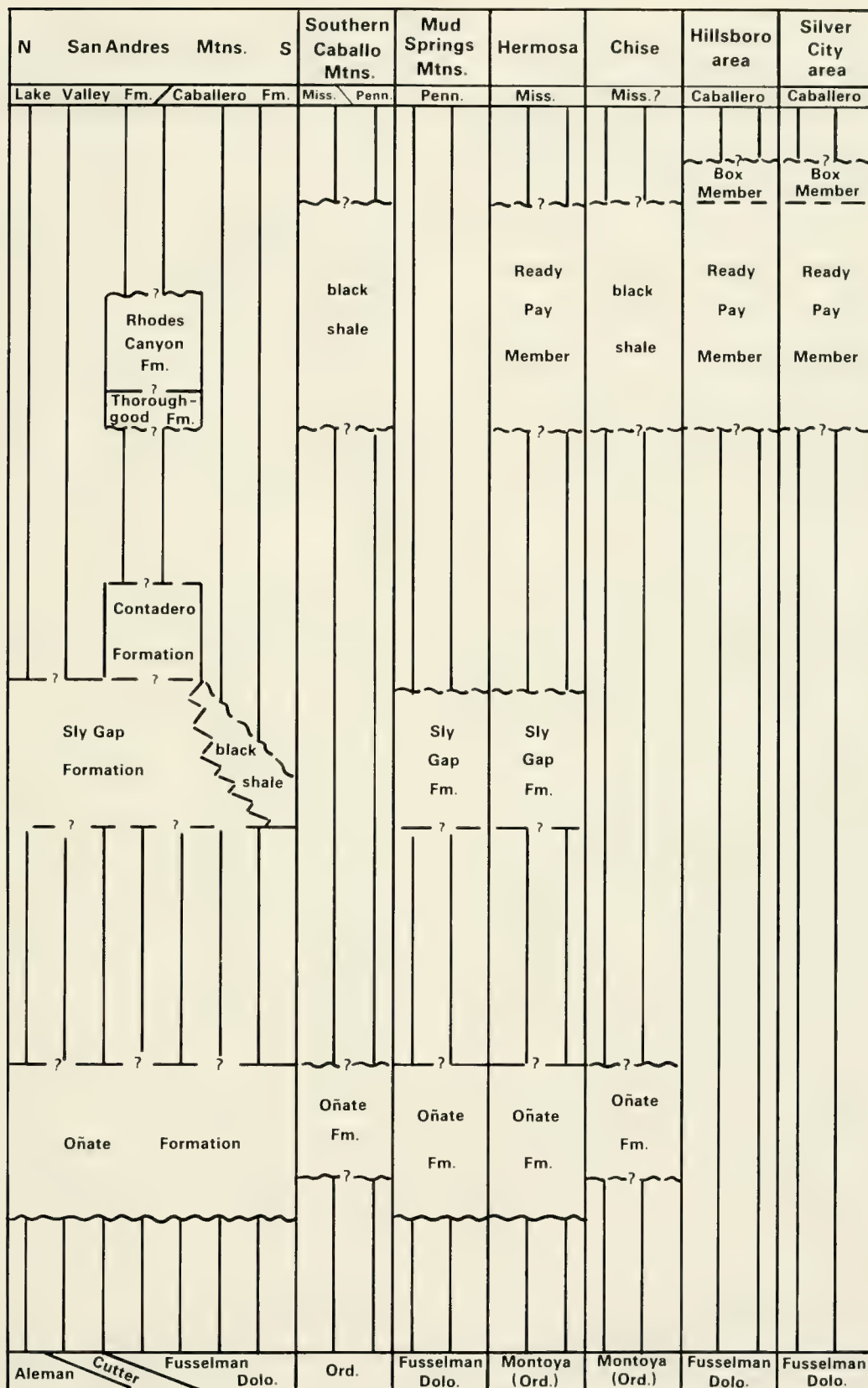
caenia, *Hypothyridina* Buckman (1906) and small individuals of *Warrenella floweri* n. sp.

At the westernmost known exposures of the Oñate Formation, near Hermosa, *Rhysochonetes* occurs in the lower 2 m (7 ft) and a characteristic assemblage is found in the upper 1 m (4 ft): *Schizophoria*, *Nervostrophia*, *Dichacaenia*, *Hypothyridina*, *Eleutherokomma*, and *Desquamatia*, together with *Cystodictya*.

An interesting variant on the Oñate brachiopod assemblage occurs in the northern part of the San Andres Mountains where the formation is only about 3 m (10

ft) thick. Two species: *Tropidoleptus platys* n. sp., occurring only on Capitol Peak and in Johnson Park Canyon, and *Acutoria angulata* n. sp., found only in Johnson Park Canyon, are especially abundant. These occur with species found elsewhere in the Oñate, including: *Nervostrophia plana* n. sp., *Nervostrophia solida* n. sp., *Schizophoria lata* Stainbrook (1940), and *Platyterorhynchus obscurum* n. sp. Also present is *Mucrospirifer*? aff. *M. sculptilis* (Hall, 1843) and *Pentamerella* sp., both links to the Middle Devonian of the eastern United States.

Stage	Cephalopod Zones		Conodont Zones		N Sacramento Mtns. S										
Overlying units					Caballero Fm. (Kinderhookian)										
Famennian	Wocklumeria		Bispatho. costatus	U. M. L.											
	Clymenia		Poly. styriacus	U. M. L.											
	Platy-clymenia	do IV	Scaph. velifer	U. M. L.											
		do III β	Palm. marginifera	U. M. L.											
		do III α													
	Cheloceras	do II β	Palm. rhomboidea												
		do II α	Palm. crepida	Upper Middle Lower										black shale ?	
	Frasnian	Manticoceras	post-do I ζ	Palm. triangularis	Upper Middle Lower										
			do I ζ	Palm. gigas	Uppermost Upper Lower										
do I γ			Ancyrognathus triangularis												
do I β			Polygnathus asymmetricus	Upper Middle Lower											
do I α															
Givetian (upper)	Maenioceras		hermanni-cristatus												
			Polygnathus varcus												
				Underlying units	U. Ord.	Fusselman				Dolo.					



Text-figure 7.—Correlation diagram of Devonian rocks in New Mexico.

BRACHIOPOD ASSEMBLAGE OF THE OÑATE FORMATION

The total brachiopod assemblage of the Oñate consists of 34 genera and 41 species. Of these, 17 genera and 20 species characterize the assemblage biologically and biostratigraphically. Three new genera, *Dichacaenia* (a strophalosiid), *Morphorhynchus* (a rhynchonellid), and *Acutoria* (a spiriferid), and 20 new species are described herein.

AGE OF THE OÑATE FORMATION

The Oñate Formation is of late Middle Devonian age (Taghanician Stage-late Givetian) and is approximately correlative with the lower Tully Limestone of New York and the lower Cedar Valley Limestone (Solon Member) of Iowa and Illinois (Text-fig. 8). The common brachiopod species in the Oñate are: *Schizophoria lata* Stainbrook (1940), *Rhysochonetes johnsoni* n. sp., *Nervostrophia plana* n. sp., *Morphorhynchus varicostatum* n. sp., *Warrenella floweri* n. sp., *W. magna* n. sp., and *Desquamatia costata* n. sp.

Schizophoria lata was described by Stainbrook from the Cedar Valley Limestone of Iowa; the *Rhysochonetes* is related both to *R. aurora* (Hall, 1867) from the lower Tully Limestone of New York and the Pine Point Formation in Canada and also to the *Rhysochonetes* that occurs in the northern Roberts Mountains, Nevada (Interval 21 of Johnson, 1978), in the Winnipegogian Limestone of Manitoba and the Solon Member of the Cedar Valley Formation of Iowa. *Nervostrophia plana* is very like *N. tulliensis* (H. S. Williams, 1890); and *Morphorhynchus varicostatum* seems related to Middle Devonian species of "*Hadrorhynchia*" reported from western Canada (McLaren, 1962).

Of the rarer forms, *Leiorhynchus sphaericum* is close to *L. castaneum* Meek (1867) from the Nevada Middle Devonian and from the Pine Point Formation. *Hadrorhynchia alta* and *H. mclareni* are related to *H. sandersoni* (Warren, 1944), also from the Pine Point Formation.

In addition to the brachiopods, the bryozoan *Cystodictya anomalotruncata* (Fritz, 1944) is common in the upper part of the formation in several places. This species is most similar to species described by McNair (1937) from the Middle Devonian of Michigan, as Fritz indicated in her paper.

Conodonts are rare in the Oñate, but a few specimens from the lower part of the formation in the Mud Springs Mountains, where they occur with *Rhysochonetes johnsoni* n. sp., were assigned by Huddle (written commun., 1974) to the *Polygnathus varcus* Zone. In New York, this zone is found in the upper

part of the Middle Devonian, from the Centerfield through the Tully formations (Klapper *et al.*, 1971). In a paper revising the *varcus* Zone (Ziegler, Klapper, and Johnson, 1976), *Rhysochonetes* is reported both in Nevada and New York with middle *varcus* Subzone conodonts.

One of the more exotic non-brachiopod elements of the fauna is *Sphaerospongia* cf. *S. tessellata* (Phillips, 1841) which is abundant in the Mud Springs Mountains in the "Sponge beds". This receptaculitid genus occurs in England and Germany in the late Middle Devonian (Warren, 1944). Wells (1940) described a specimen from the upper Tully Limestone in New York and discussed occurrences in the Winnipegogian Limestone in Manitoba and the Torquay Limestone in

Table 1.—Brachiopods of the Oñate Formation (+ = especially important elements).

<i>Lingula</i> species 3
<i>Lingula</i> species 4
<i>Trigonoglossa</i> ? species
<i>Orbiculoidea</i> species
<i>Petrocrania</i> species 1
+ <i>Schizophoria lata</i> Stainbrook
<i>Schizophoria</i> species 1
<i>Rhipidomella</i> species 2
+ <i>Tropidoleptus platys</i> new species
<i>Strophodonta</i> species 1
+ <i>Nervostrophia plana</i> new species
" <i>Schuchertella</i> " species
<i>Devonochonetes</i> ? species
+ <i>Striatochonetes nanus</i> new species
<i>S. subcarinatus</i> new species
+ <i>Rhysochonetes johnsoni</i> new species
<i>Eostrophalosia</i> species 1
+ <i>Dichacaenia perplexa</i> new genus and species
+ <i>D. umbonata</i> new genus and species
<i>Pentamerella</i> species
<i>Cupularostrum</i> ? species
+ <i>Morphorhynchus varicostatum</i> new genus and species
<i>Hypothyridina</i> species
+ <i>Hadrorhynchia alta</i> new species
+ <i>H. mclareni</i> new species
+ <i>Leiorhynchus sphaericum</i> new species
+ <i>Platyterorhynchus obscurum</i> new species
+ <i>Atryparia rubra</i> new species
+ <i>Desquamatia costata</i> new species
<i>Emanuella</i> species
<i>Echinocoelia pretiosa</i> new species
+ <i>Eleutherokomma extensa</i> new species
+ <i>Mucrospirifer parvus</i> new species
cf. <i>M.?</i> <i>sculptilis</i> (Hall)
+ <i>Acutoria angulata</i> new genus and species
<i>Orthospirifer</i> species
<i>Spinocyrtia</i> ? species
+ <i>Warrenella floweri</i> new species
+ <i>W. magna</i> new species
+ <i>Cyrtina variabilis</i> new species
<i>Cranaena</i> species 1

Devonshire, England. A similar species also occurs in the Middle Devonian Hare Indian Shale of northwestern Canada (Warren and Stelck, 1956).

SLY GAP FORMATION

(Pl. B; Pl. C, figs. 1, 2)

TYPE SECTION AND GENERAL STRATIGRAPHY

The type section of the Sly Gap Formation (Stevenson, 1945) is on the south slope of Sheep Mountain (loc. 506j) in the northern part of the San Andres Range (Pl. B, figs. 1, 2). The sequence is dominantly shaly and is composed of dark gray laminated shaly units alternating with greenish gray nodular units, not unlike Percha lithic types but lighter in color. The calcareous nodules are particularly dense in the lower, middle and uppermost parts of the formation. These fossiliferous nodular zones are, essentially, units D, G, and uppermost unit H of Stevenson (1945). Although Stevenson originally considered the Sly Gap to be about 35 m (115 ft) thick, our work has shown that: unit C, at the base, is the Oñate Formation; units I and J belong to the Contadero Formation; and the upper two units (K and L) are assigned to the Thoroughgood Formation.

Consequently, the revised Sly Gap of the type section is about 20 m (65 ft) thick. This includes Stevenson's units D through H (1945, fig. 9). Measurements made by us, although differing in details, indicate that the Sly Gap varies in thickness from about 20 to 22 m (65 to 70 ft) in the type area. To the north, it thins to about 12 m (40 ft) at Johnson Park (formerly Mockingbird Gap) where rocks of early Mississippian age unconformably overly this formation. Post-Sly Gap strata apparently were removed by late Devonian erosion in the northernmost part of the San Andres Mountains. In the Rhodes Pass area, south of the type section, the Sly Gap Formation is about 24 m (80 ft) thick. The formation thins to less than 12 m (40 ft) at San Andres Canyon and is either missing in the southern San Andres Mountains or is replaced by a dark shale facies to the south.

In the Sacramento Mountains, the Sly Gap varies in thickness from about 9 to 20 m (30 to 65 ft). The variation is again apparently due to late Devonian erosion, as the early Mississippian Caballero Formation everywhere lies disconformably on the Sly Gap. South of Mule Canyon, the Caballero lies disconformably on the Oñate Formation and the Sly Gap is missing.

In the Mud Springs Mountains, the Sly Gap is about 16 m (54 ft) thick and is overlain unconformably by strata of Pennsylvanian age. This is also the case in the Derry Hills, where the Sly Gap is probably no thicker than 12 m (40 ft).

Layers of black shale that occur in the Sly Gap in Marble Canyon and in the southern part of the Sacramento Mountains have been erroneously interpreted as tongues of Ready Pay black shale, producing the equally erroneous interpretation that the Sly Gap is a facies of the Ready Pay.

The westernmost exposures near Hermosa contain about 12 m (40 ft) of Sly Gap beds that overlie the Oñate and are disconformably overlain by the Ready Pay Member of the Percha Shale.

FOSSIL CONTENT AND DISTRIBUTION

In the type area, and elsewhere in the northern part of the San Andres Mountains north of Rhodes Pass, the characteristic brachiopod assemblages of the Sly Gap are superbly developed. Although many of the species range through the entire thickness of the formation, occurrences suggest there is an approximate five-fold zonation, discussed below:

Colonial Coral Zone

The upper 1.5 to 2.5 m (5 to 8 ft) contains abundant corals, including *Alveolites* Lamarck (1801), *Pachyphyllum* Milne-Edwards and Haime (1850), "*Hexagonaria*", together with *Macgeea* Webster (1889b) and a few brachiopods. This zone is equivalent to the upper part of Stevenson's (1945) unit H.

Upper Brachiopod Zone

About 5 to 6 m (17 to 20 feet) of strata below the coral zone consists of characteristically nodular shale with many brachiopod species and the coral *Macgeea*. It was also from this level that the ammonite *Manticoceras* Hyatt (1884) was reported. Collection 521q represents this assemblage well. Common species are: *Aulacella elliptica* n. sp., *Nervostrophia geniculata* n. sp., *N. mucrospina* n. sp., *Douvillina parviuscula* n. sp., *Devonoproductus intermedius* n. sp., *Costatrypa varicostata* (Stainbrook, 1945), *Iowatrypa rara* n. sp., *Pseudotrypa devoniana* (Webster, 1921), *Thomasaria warreni* n. sp., *Elita magister* n. sp., *Cyrtina inulta* Stainbrook (1945), and *Indospirifer anomala* n. sp. The highest occurrence of *Hypothyridina* Buckman (1906) is near the base of this unit. This zone is equivalent to the middle part of Stevenson's unit H.

Lower Brachiopod Zone

The next lower 6 m (20 ft), or so, also contains a variety of brachiopods, and *Macgeea*—the common solitary coral found all through the Sly Gap. Collection 521k contains many of the species that comprise the typical Sly Gap brachiopod assemblage, including:

Stage	Cephalopod Zones	Conodont Zones	New Mexico		Arizona		
Overlying units			Miss.	Penn.	Escabrosa Fm.		
Famennian	<i>Wocklumeria</i>	<i>Bispatho. costatus</i>	U.				
			M.				
			L.				
	<i>Clymenia</i>		U.				
		<i>Poly. styriacus</i>	M.	Box Mbr.		upper beds	"Ouray"
			L.				
	<i>Platyclymenia</i>	<i>Scaph. velifer</i>	U.				
			M.				
			L.				
		<i>Palm. marginifera</i>	U.				
			L.				
		<i>Palm. rhomboidea</i>					
	<i>Cheiloceras</i>	<i>Palm. crepida</i>	Upper				
			Middle				
			Lower				
		<i>Palm. triangularis</i>	Upper				
			Middle				
			Lower				
Frasnian	<i>Manticoceras</i>	<i>Palm. gigas</i>	Uppermost	Contadero Formation			
		<i>Palm. gigas</i>	Upper	Sly Gap Formation			
			Lower				
		<i>Ancyrognathus triangularis</i>					
		<i>Polygnathus asymmetricus</i>	Upper				
			Middle				
			Lower				
			Lowermost (<i>P. dengleri</i>)				
Givetian (upper)	<i>Maenioceras</i>	<i>hermanni-cristatus</i>					
		<i>Polygnathus varcus</i>	Upper	Oñate Formation			
			Middle				
			Lower				
Underlying units			Ord.	Sil.	Precamb.	Camb.	M. Dev.

Colorado	West Texas	Nevada		Utah (Central)	Montana (Southwest)	Alberta	Iowa	Michigan	New York	
Leadville Ls.	Miss.	Central	Eastern	Miss.	Miss.	Miss.	Kinderhook	Miss.	Knapp Cgl.	
? ? ? Dyer Ouray Chaffee ? ? ? Parting Mbr. Elbert Fm. Aneth Fm. ? ? ?				Fitchville Fm. (part) Pinyon Peak Limestone ? Pilot Shale (part) West Range Ls. ? Victoria Fm. Mbr. d Mbr. c ? Bluebell Dolo. (part) ? Mbr. a	Sappington Mbr. (part) Trident Mbr. ? Three Forks Formation Logan Gulch Mbr. ? Jefferson Formation Bird bear Mbr. ? Maywood Fm. ?	Palliser Alexo ? Mount Hawk Perdrix Maligne Flume ?	English R. Ss. ? Maple Mill Shale Aplington ? Sheffield Fm. ? Owen Lime Creek Independence Shale ? Shell Rock ? State Quar. ? Cedar Valley Fm. Coralville Rapid Solon Mbr. Wapsipinicon	Ellsworth Shale ? Antrim Shale ? Norwood Shale ? Jordan R. Squaw Bay ? Thunder Bay Potter Farm ? Norway Point Four Mi. Dam	Conevangoan Amity Sh. ? Cassadagan Ellicott Shale Dexterville Shale Northeast Shale Shumla Ss. Westfield Shale Gowanda Dunkirk Shale Cohoctonian Hanover Shale - Wiscoy Fm. Nunda Ss. West Hill Grimes Rhinestreet Sh. Naples Grp. West River Shale Genundewa Ls. Penn Yan Shale Lodi Ls. Genesee Shale Fingerlakesian Tully Formation Moscow Fm. Ludlowville Fm. Centerfield Ls. Tiough-niogan Hamilton Grp. (lower)	
Camb. Ord.	Fusselman	M. Dev.	Simonson (part)	Silurian	Beartooth Butte Fm.	Camb. Ord.	Ord. Sil.	Traverse Grp. (lower)	Hamilton Grp. (lower)	

Text-figure 8.—Correlation of New Mexico Devonian strata with selected Devonian sequences in North America. Members of Guilmette Formation from Drewes (1967).

Calvinaria bransonii Stainbrook (1948), *Cariniferella allenii* n. sp., *Coeloterorhynchus magnificum*, n. sp., *Costatrypa extensa* n. sp., *Cyrtina inulta*, *Devonoproductus intermedius* n. sp., *Gypidula subcarinata* n. sp., *Hypothyridina emmonsii* *rotunda* n. subsp., *Indospirifer* aff. *I. orestes* (Hall and Whitfield, 1872), *Nervostrophia mucrospina* n. sp., *Productella rugulata* Stainbrook (1945), *Pseudoatrypa devoniana*, *Schizophoria iowensis* (Hall, 1858), *Spinatrypa trulla decorticata* n. subsp., *Thomasaria warreni* n. sp., *T. demissa* n. sp., and *Tylothyris sulcocostrata* n. sp. This zone is equivalent to the lower part of Stevenson's unit H and his unit G (Stevenson, 1945).

Atrypa Zone

This zone is essentially equivalent to Stevenson's (1945) unit E and includes a variety of the atrypids that are listed above for the lower brachiopod zone, but lacks the wide variety of species of that zone.

Macgeea Zone

Although the little horn coral *Macgeea* is found throughout the Sly Gap, its lowest occurrence is near the base of the formation where it is found with a sparse brachiopod fauna that includes *Cyrtina* Davidson (1858) and *Coeloterorhynchus* Sartenaer (1966a). This zone is equivalent to Stevenson's unit D (1945), the lower 2.5 m (8 ft) of the type section.

These five occurrence zones hold up reasonably well in the San Andres Mountains wherever the upper beds have not been removed by later erosion. Several collections, especially those made in the earlier days and those collected from slope intervals where there may be mixing from the higher beds, contain elements of two or more of these intervals.

A similar zonation is found in the Sacramento Mountains, although species abundances differ and the uppermost coral beds are nowhere found. The *Hypothyridina* beds, near the middle of the formation, provide a good marker horizon throughout the Sacramentos and, where they occur at the top of the formation—as at Alamo Peak and Indian Wells Canyon—they demonstrate the depth of post-Sly Gap erosion in this area.

In the Mud Springs Mountains section, the diversity of species is considerably less than in areas to the east. Nevertheless, a number of species in the upper 6 m (20 ft) can be related to those of the lower brachiopod zone of the San Andres Mountains. In the Mud Springs Mountains, pre-Pennsylvanian erosion (perhaps several episodes) has removed both the upper brachiopod zone and the uppermost colonial coral zone.

At Hermosa (Pl. B, fig. 2), only four brachiopod species were collected from near the top of the Sly Gap beds, but these strongly suggest a sparse representation of the upper brachiopod zone.

BRACHIOPOD ASSEMBLAGE OF THE SLY GAP FORMATION

The total brachiopod assemblage of the Sly Gap consists of 38 genera and 66 species. Twenty-eight genera and 37 species are particularly useful in characterizing the paleontologic make-up of the assemblage and in correlating it with other Frasnian faunas. An indication of the widespread and well-known distribution of this assemblage, at the generic level, is that only one new genus is described in this paper, this even though many man-weeks were spent in the field and hundreds of specimens were studied during the description of this large number of species.

AGE OF THE SLY GAP FORMATION

The Sly Gap Formation is early Late Devonian (Frasnian-Cohoctonian Stage) in age on the basis of the rich brachiopod assemblage that was first described by Stainbrook (1948). While Stainbrook described 25 species, assigned to 24 genera, our collecting since 1948 has resulted in the accumulation of the large brachiopod assemblage listed in Table 2. Twenty of these species were previously described, 31 are new, and 16 are either too rare or too poorly preserved to warrant formal description.

Although the Sly Gap brachiopods and the Independence Shale fauna of Iowa are related, as indicated by Stainbrook (1948), they are not as similar as it would appear from his earlier work (1945).

The Sly Gap appears to be mid-Frasnian in age, approximately equivalent to the Lime Creek Formation of Iowa. A number of common or related species in the Mount Hawk Formation of Alberta indicates correlation with a part of that formation (Text-fig. 8).

Conodonts in the Sly Gap itself are rare and all that have been identified so far are non-diagnostic, long-ranging forms. An upper limit on the Frasnian age, however, is provided by the conodonts and brachiopods of the overlying Contadero Formation. These brachiopods are clearly late Frasnian and conodonts from the basal Contadero Formation at Sheep Mountain indicate a maximum age range of *Ancyrognathus triangularis* through upper *Palmatolepis gigas* zones (J. W. Huddle, written comm., 1973; A. G. Harris, oral commun., 1977).

The Frasnian cephalopod, *Manticoceras*, is reported from the middle part of the type section. Corals

from the Sly Gap include: *Macgeea* Webster (1889b), *Alveolites* Lamarck (1801), "*Hexagonaria*" Gürich (1896), and *Pachyphyllum* Milne-Edwards and Haime (1850), all similar to the well-known Frasnian coral fauna of the Lime Creek Formation of Iowa. James Sorauf (State University of New York, Binghamton, NY), who has recently completed a detailed study of the Iowa coral fauna, is also studying the Frasnian corals of New Mexico. His research, when completed, will provide much detail on the nature of the coral fauna and its correlatives elsewhere in North America.

CONTADERO FORMATION

TYPE SECTION AND GENERAL STRATIGRAPHY

The type section of the Contadero Formation, proposed by Stevenson (1945), is in Rhodes Canyon in the San Andres Mountains (loc. 526g). Although Stevenson originally included all the post-Sly Gap beds in this formation, later refinements by Flower (1958, 1959, 1965, 1969, 1970) place the higher beds in Flower's Thoroughgood and Rhodes Canyon formations.

Thickness measurements in the type section vary slightly, but the Contadero is about 14 m (between 45 and 50 ft) thick. Flower (1970) indicates that the revised Contadero is 13.5 m (45 ft) thick; we measured 14.5 m (49 ft) of strata there that we consider to belong to the Contadero. The lower 11 m (36 ft) consists of alternating layers of dark gray shale and yellowish brown siltstone or fine-grained sandstone, and the basal 0.6 m (2 ft) is predominantly sandstone. There are about 20 thin silty or sandy units through this lower part of the formation. The next higher unit, about 1.2 m (4 ft), is calcareous shale with many brachiopods and the uppermost 2.5 m (9 ft) consists of dark gray, nodular limestone containing large horn corals.

The Contadero Formation also is present at the type section of the Sly Gap (Pl. C, fig. 3), although Stevenson did not recognize it as such, in his 1945 paper. On Sheep Mountain, the Contadero consists of about 6 m (20 ft) of shale and siltstone with corals in the uppermost foot or so. The formation also is found to the south of Rhodes Canyon as far as San Andres Canyon and varies between 6 and 20 m (20 to 65 ft) thick throughout the area of exposure.

Table 2.—Brachiopods of the Sly Gap Formation (+ = especially important elements).

<i>Philhedra</i> species	<i>D. vulgaris</i> Stainbrook
<i>Petrocrania</i> species unident.	+ <i>Gypidula bowsheri</i> new species
+ <i>Schizophoria amanaensis</i> Stainbrook	+ <i>G. mimica</i> new species
+ <i>Schizophoria iowensis</i> (Hall)	+ <i>G. subcarinata</i> new species
<i>Schizophoria</i> species 2	<i>Athabascia</i> ? species 1
+ <i>Aulacella elliptica</i> new species	+ <i>Hypothyridina emmonsii rotunda</i> new subspecies
+ <i>Cariniferella allenii</i> new species	+ <i>Coeloterorhynchus magnificum</i> new species
<i>Cariniferella iowensis</i> Stainbrook	+ <i>Calvinaria bransonii</i> Stainbrook
<i>C.</i> species	+ <i>Hyborhynchella bransonii</i> Cooper
+ <i>Rhipidomella</i> species 1	+ <i>Pseudoatrypa devoniana</i> (Webster)
+ <i>Strophodonta umbonata</i> new species	+ <i>Costatrypa extensa</i> new species
<i>S.</i> species 2	+ <i>C. varicostata</i> (Stainbrook)
+ <i>Strophonelloides dorsoconvexus</i> new species	+ <i>Iowatrypa rara</i> new species
+ <i>S. parvulus</i> new species	+ <i>Spinatrypa trulla decorticata</i> new subspecies
<i>Nervostrophia extensa</i> new species	<i>Ambocoelia</i> species 1
+ <i>N. geniculata</i> new species	+ <i>Tylothyris sulcocostata</i> new species
+ <i>N. mucrospina</i> new species	+ <i>Acutatheca prolifica</i> new species
<i>N. multinervosa</i> Stainbrook	+ <i>Thomasaria warreni</i> new species
+ <i>N. solida</i> new species	+ <i>Thomasaria demissa</i> new species
+ <i>Pseudodouvillina euglyphea</i> Stainbrook	+ <i>Cyrtospirifer</i> cf. <i>C. thalattodoxa</i> Crickmay
<i>Sulcatostrophia calvini</i> (Miller)	<i>C. whitneyi</i> (Hall)
<i>Douvillina arcuata</i> (Hall)	<i>C.</i> species 3
<i>D. minuta</i> new species	<i>C.</i> species 4
+ <i>D. parviuscula</i> new species	<i>C.</i> species 5
<i>D. rectangulata</i> new species	<i>Tenticospirifer</i> cf. <i>T. cyrtinaformis</i> (Hall & Whitfield)
<i>D.</i> species 1	<i>Indospirifer anomala</i> new species
+ <i>Douvillinaria diversa</i> new species	+ <i>I. exfoliata</i> new species
+ <i>D. variabilis</i> (Calvin)	<i>I.</i> aff. <i>I. orestes</i> (Hall & Whitfield)
<i>Floweria prava</i> (Hall) [new genus]	+ <i>Elita magister</i> new species
+ <i>F. magnacatrix</i> new species	+ <i>Cyrtina inulta</i> Stainbrook
<i>Eostrophalosia inexpectata</i> new species	<i>Cranaena calvini</i> (Hall & Whitfield)
<i>Productella rugatula</i> Stainbrook	<i>C.</i> species 2
+ <i>Devonoproductus intermedius</i> new species	

The Contadero Formation has not been recognized outside of the San Andres Mountains.

FOSSIL CONTENT AND DISTRIBUTION

Except for the undescribed coral assemblage at its top, the fauna of the Contadero is composed mainly of brachiopods. These are concentrated at two levels, one in the basal 3 m (10 ft) or so and the other near the top, just below and including the coral-bearing beds. No particular zonation is seen; the several common species appear to be present throughout the formation. Only four species range upward from the Sly Gap: *Aulacella elliptica* n. sp., *Coeloterorhynchus magnificum* n. sp., *Cyrtospirifer whitneyi* (Hall, 1858) and *Cyrtina inulta* Stainbrook (1945). Two new genera appear in this assemblage: *Stainbrookia* and *Colophragma*.

As indicated in the discussion of the age of the Sly Gap, conodonts were found in the lowermost bed of the Contadero, and are helpful in establishing a datum for the ages of both units.

Both the Sly Gap and Contadero coral assemblages are under study by J. Sorauf (State University of New York, Binghamton, NY).

BRACHIOPOD ASSEMBLAGE OF THE CONTADERO FORMATION

There are fewer brachiopod species in the Contadero than in either the Oñate or Sly Gap formations, but the assemblage of the Contadero is about twice as diverse as those of the Thoroughgood and Rhodes Canyon formations.

The Contadero brachiopod assemblage consists of 20 genera and 24 species, of which nine genera and 11 species serve to distinguish it from other Devonian assemblages in New Mexico. Three new genera and 10 new species are recognized.

AGE OF THE CONTADERO FORMATION

The brachiopods clearly indicate that the Contadero is late Frasnian in age. The presence of true atrypids, with *Douvillina* Oehlert (1887) and a group of distinctive rhynchonellid genera, indicates that it is pre-Famennian. The abundance of *Cyrtospirifer whitneyi* (Hall, 1858) and *Uchtospirifer? rarus* n. sp. suggests that the assemblage is approximately a correlative of the lower part of the *Cyrtospirifer* Zone, which spans the late Frasnian-early Famennian interval in the western part of the United States (Text-fig. 8).

As indicated in the discussion of the age of the Sly Gap, the late Frasnian conodonts at the base of the Contadero support the late Frasnian age shown by the

brachiopods. Although no precise upper limit can be placed on the age of the Contadero, the presence of two species of *Spinatrypa* in the upper part of the formation indicates that it probably is entirely Frasnian. No atrypids are known from Famennian strata anywhere in the world. Therefore, the Contadero cannot be placed in the Famennian as Poole *et al.* (1967, p. 887) indicate in their correlation chart.

THOROUGHGOOD FORMATION

TYPE SECTION AND GENERAL STRATIGRAPHY

The type section of the Thoroughgood Formation is on Sheep Mountain (Flower, 1958, 1969, 1970) where it consists of 3 to 4 m (10–12 ft) of beds that lie above the Contadero (loc. 522). Along with the Contadero strata, these beds were also originally a part of Stevenson's Sly Gap Formation (1945), and his units K and L are now included in the Thoroughgood (Pl. C, fig. 4). A thin remnant of the formation is preserved in Rhodes Canyon and Deadman Canyon to the south. In each place, only about 15 to 20 cm of sandstone remain, but this contains early Famennian conodonts.

The Thoroughgood is essentially a light gray, fine-grained sandstone that weathers yellowish brown. It is calcareous in places. The basal few cm contains phosphatic pebbles and, although Stevenson (1945) refers to it as the "fish zone", no fish remains were

Table 3.—Brachiopods of the Contadero Formation (+ = especially important elements).

	<i>Barroisella</i> species
	<i>Orbiculoidea</i> species 1
	<i>Schizophoria</i> species
	<i>Aulacella elliptica</i> new species
+	<i>Stainbrookia rotunda</i> new genus and species
	<i>Thiemella quadrata</i> new species
+	<i>Douvillina</i> aff. <i>D. cayuta</i> (Hall)
+	<i>D.</i> species 2
+	<i>Floweria</i> aff. <i>F. chemungensis</i> (Conrad) [new genus]
	<i>Productella?</i> species 2
+	<i>Cupularostrum? stevensoni</i> new species
+	<i>Ripidiorhynchus newmexicoense</i> new species
	<i>Coeloterorhynchus magnificum</i> new species
+	<i>Colophragma ellipticum</i> new genus and species
	<i>C.</i> species 1
+	<i>Spinatrypa compacta</i> new species
+	<i>S. obsolescens</i> new species
	<i>Ambocoelia</i> species 2
+	<i>Tylothyrus novamexicana</i> Stainbrook
	<i>T.</i> species 1
	<i>Cyrtospirifer whitneyi</i> (Hall)
+	<i>Uchtospirifer? rarus</i> new species
	<i>Cyrtina inulta</i> Stainbrook
	<i>Cranaena navicella</i> (Hall)

found by us. The formation has not been identified elsewhere in south-central New Mexico.

FOSSIL CONTENT AND DISTRIBUTION

Only one collection of megafossils has come from the Thoroughgood (loc. 522) and this is from the lowermost part. In addition to the small brachiopod assemblage, an indeterminate orthoconic nautiloid cephalopod and a loxonematid gastropod were also found at this level (Flower, 1970).

BRACHIOPOD ASSEMBLAGE OF THE THOROUGHGOOD FORMATION

This small, though distinctive, group of brachiopods includes nine genera and 11 species of which five genera and six species serve to characterize the assemblage for biostratigraphic and age considerations. *Colophragma* and *Crinisarina* are new, as are three species.

AGE OF THE THOROUGHGOOD FORMATION

None of the characteristic Frasnian species found in the Sly Gap and Contadero formations carries over into the Thoroughgood. The presence of abundant *Cyrtospirifer* Nalivkin (in Fredericks, 1924) and *Crinisarina* n. gen., together with *Evanescirostrum* Sartenauer (1965), and the absence of atrypids indicate an early Famennian age (Text-fig. 8). According to Sartenauer (1969), *Evanescirostrum* does not occur before the Famennian.

Conodonts in the thinned remnant of the Thoroughgood in Deadman Canyon in the San Andres Mountains are of early Famennian age (J. Huddle, written commun., 1974).

Apparently, the Thoroughgood and Rhodes Canyon formations of the San Andres Mountains are approximate equivalents to the Ready Pay Member of the Percha Formation, all three units being of early Famennian age.

Table 4.—Brachiopods of the Thoroughgood Formation (+ = especially important elements).

<i>Productella</i> species 3
<i>Athabascchia</i> ? species 2
<i>Colophragma</i> species 2 [new genus]
+ <i>Camarotoechia latissinuata</i> new species
+ <i>Evanescirostrum</i> species 1
<i>Ambocoelia</i> species 3
+ <i>Tylothyris compacta</i> new species
+ <i>Cyrtospirifer arenarius</i> new species
+ <i>C.</i> species 1
<i>C.</i> species 2
+ <i>Crinisarina reticulata</i> (Stainbrook) [new genus]
<i>Afilasma</i> species

RHODES CANYON FORMATION

TYPE SECTION AND GENERAL STRATIGRAPHY

The type section of the Rhodes Canyon Formation is in Rhodes Canyon (locs. 509t, u) where Flower (1958, 1959, 1969, 1970) applied the name to about 18 m (60 ft) of dark gray, predominantly non-calcareous shale that lies above the thin remnant of the Thoroughgood Formation. The lower 3 m (10 ft) is mainly silty, dark gray, non-calcareous shale with a few brachiopods in the upper 25 cm. The overlying 6 m (20 ft) is fissile, non-calcareous shale with interbeds of siltstone. This interval is very sparsely fossiliferous. The next highest interval, about 3 m (10 ft) thick, is gray, calcareous siltstone and silty shale with abundant brachiopods. Finally, at the top, there is about 6 m (20 ft) of slightly calcareous silty shale and dark gray, fissile clay shale with a few brachiopods, as below.

The Rhodes Canyon Formation has been definitely identified elsewhere only at Ash Canyon, to the south of the type area. Beds considered to be post-Contadero, but Devonian, by Kottowski *et al.* (1956) in Hembrillo Canyon are Mississippian in age.

Based on stratigraphic position, age relationships and general lithic appearance, the Rhodes Canyon Formation is probably correlative to all, or a part of, the Ready Pay Member of the Percha Formation. Consequently, the Rhodes Canyon and Thoroughgood formations are interpreted as more shoreward facies of the dominantly unfossiliferous Ready Pay dark shales that are indicative of deeper or stagnant water.

FOSSIL CONTENT AND DISTRIBUTION

Brachiopods are common in the Rhodes Canyon, but there is little differentiation in the fauna from bottom to top of the unit. Collections from the bottom 2 m (6 ft) are similar to those from the calcareous shales higher up and to the highest collection, about 1 m (3 ft) below the top of the type section.

No fossils other than brachiopods were collected and no conodonts have been identified from this formation.

BRACHIOPOD ASSEMBLAGE OF THE RHODES CANYON FORMATION

The brachiopod assemblage consists of 11 genera and 16 species. Seven genera and eight species are considered significant for characterization of the assemblage. Particularly abundant are the spiriferids: *Cyrtospirifer pyramidalis* n. sp., *Tylothyris novamexicana* Stainbrook (1947), and *Crinisarina reticulata* (Stainbrook, 1947). The last is assigned to a new genus

of athyrids that is common in other Famennian assemblages in western North America. Also important are the rhynchonellids, including *Evanescirostrum glabraventrum* (Stainbrook, 1947), *Ripidiorhynchus newmexicoense* n. sp., and *Cupularostrum? stvensoni* n. sp. The latter two species are long-ranging forms, but the first is restricted to this formation.

AGE OF THE RHODES CANYON FORMATION

Brachiopods indicate a definite Famennian age, probably mid-Famennian. *Crinisarina* n. gen. is proposed to include a group of species that are common in middle Famennian strata throughout the western part of North America. Species in the new genus previously have been referred to *Athyris* or *Cleiothyridina* by many writers. Species closely related to the Rhodes Canyon form are found in the upper Palliser Formation in Alberta, the Trident Member of the Three Forks Formation in Montana, the Port Refugio Formation of Alaska, and the lower Pilot Shale in Nevada. The occurrence of *Evanescirostrum* Sartenaer (1965) with *Crinisarina* also strengthens the Famennian correlation (see Sartenaer, 1969). Consequently, we feel that the Rhodes Canyon assemblage is approximately equivalent to the early *Platyclymenia* Zone (Text-fig. 8).

Sartenaer (1969, fig. 3) correlated the Rhodes Canyon with the Box Member of the Percha Shale, making both units late Famennian in age. The brachiopods of the Rhodes Canyon have little in common with those of the Box Member and, while we agree with Sartenaer that the Box Member is probably early late Famennian, we think the Rhodes Canyon is older than the Trident Member of the Three Forks.

Table 5.—Brachiopods of the Rhodes Canyon Formation (+ = especially important elements).

+	<i>Aulacella elliptica</i> new species
+	<i>A. manticula</i> (Stainbrook)
	" <i>Schuchertella</i> " species undetermined
	<i>Productella</i> species 1
+	<i>Cupularostrum? stvensoni</i> new species
	<i>Ripidiorhynchus newmexicoense</i> new species
+	<i>Evanescirostrum glabraventrum</i> (Stainbrook)
+	<i>Crinisarina reticulata</i> (Stainbrook) [new genus]
+	<i>Tylothyrus novamexicana</i> Stainbrook
	<i>T.</i> species 1
	<i>Cyrtospirifer breviposticus</i> Stainbrook
+	<i>C. pyramidalis</i> new species
	<i>C.</i> species indeterminate
+	<i>Afilasma inexpectatum</i> new species
	<i>Cyrtina</i> species indeterminate

PERCHA FORMATION (READY PAY MEMBER) (Pl. D, fig. 2)

TYPE SECTION AND GENERAL STRATIGRAPHY

The type section of the Percha Formation was chosen by Stevenson (1945) although the formation had been named years earlier by Gordon (1907). As Stevenson explained, Gordon did not select a type section but indicated that the type locality was on Percha Creek in the vicinity of Hillsboro, New Mexico. As described by Stevenson, the Ready Pay Member consists of about 36 m (120 ft) of black, fissile shale with occasional green shale lenses, that grades upward into about 3.6 m (12 ft) of gray, argillaceous shale. Stevenson reports, and our examination of relationships in the type area confirms, that the Ready Pay grades upward into the calcareous nodular shale and limestone of the lower Box Member.

Throughout the type region, the Ready Pay lies unconformably on the Fusselman Dolomite of Silurian age. In several places we collected samples of the sandy, phosphatic basal beds that occur just above the unconformity. In all instances where definitive conodonts were found, they represent early Famennian conodont zones or ranges that are approximately the same as those reported from just above the Sly Gap Formation in the Hermosa section. There is no question that all of the Percha Shale is younger than Frasnian and, thus, younger than the Sly Gap and Contadero formations of the San Andres Mountains.

Shales with conodonts of the same age are reported from three other places in south-central New Mexico (Huddle, written commun., 1973, 1974). At two localities in the southern Caballo Mountains, shale that is the equivalent of the Ready Pay lies unconformably on the Oñate Formation. The third locality is in Deadman Canyon, in the Sacramento Mountains. Here the conodonts occur in a thin black shale unit (about 1.5 m thick) that lies above the Sly Gap and below the Mississippian Caballero Formation.

As indicated above, conodonts at the base of the Thoroughgood Formation are also of early Famennian age. Thus, the Thoroughgood and Rhodes Canyon formations are approximate correlatives of the Ready Pay Member. In none of the eastern areas, however, is an equivalent of the Box Member found.

FOSSIL CONTENT AND DISTRIBUTION

Except for the conodonts mentioned above, fossils are extremely rare in the Ready Pay Member. Three species of brachiopods (*Retichonetes obscurus* n. sp., *Paurorhyncha cooperi* Stainbrook (1947) and *Syrin-*

gospira prima Kindle (1909)) were found in the upper part of the member at Bear Mountain, north of Silver City. All also are present in the brachiopod assemblage of the Box Member. A fourth species, *Lingulipora porifera* n. sp., was found only in the basal beds of the Ready Pay Member about 1.5 mi south of the Wilson Ranch in the Hillsboro (15') quadrangle (loc. 3037).

A few scraps of plant material were seen in the lower m or so of silty beds at the Bear Mountain locality, but they are indeterminate.

BRACHIOPOD ASSEMBLAGE OF THE READY PAY MEMBER

Only six species of brachiopods have been collected from the Ready Pay Member. The species of *Lingulipora* in the basal beds confirms the shallow-water origin of those silts, the initial deposits in the Famennian onlap. The other species in the upper part, being common elements of the overlying Box Member assemblage, reflect the gradational nature of the contact between the two members.

AGE OF THE READY PAY MEMBER

Conodonts from several localities in the basal sandy and silty beds of this member indicate that it is no older than early Famennian (Text-fig. 8). Four collections studied by Huddle (written commun., 1973, 1974) yielded abundant conodonts and he suggested that, although various elements of the assemblage indicate a range from the *crepida* to the lower *marginifera* zones, a few short-ranging forms indicate that the latter age is more likely.

The conodonts indicate that the Ready Pay is probably a black facies of the Thoroughgood-Rhodes Canyon formations, not of the Sly Gap as proposed by Poole *et al.* (1967, p. 887).

Goniatites from the middle or upper parts of the Box Member were discussed by House (1962) who suggests that they indicate an age no older than the upper *Platyclymenia* Zone. His comparison of a large specimen of *Cyrtoclymenia* Hyatt (1884) with one from the *Clymenia*-Stufe at Dasburg implies that the age may be

slightly younger. In any case, the goniatites from the Box Member point to a correlation slightly younger than the *Platyclymenia* Zone assemblage of the Three Forks Formation. This would be the equivalent of the lower or middle *styriacus* Zone, in terms of the conodont zonation. House (1962, p. 262) states, "The Percha ammonoids suggest a slightly younger age than those of the Three Forks Shale."

PERCHA FORMATION (BOX MEMBER) (Pl. D, figs. 1, 3, 4)

TYPE SECTION AND GENERAL STRATIGRAPHY

The type section location was discussed above, relative to that of the Ready Pay Member. The Box Member, at the type section (loc. 507h) is 14 m (46.5 ft) thick and is composed essentially of gray calcareous shale that contains fine-grained limestone nodules and a few hard gray limestone beds (Pl. D, fig. 1). The member is dominantly shaly, as at the type section, at several sections near Kingston, Georgetown, and Hillsboro in the Black Range region, and thicknesses vary from about 9 m (30 ft) to 15 m (50 ft). The entire formation thickens westward to the vicinity of Silver City where the Box Member is about 20 to 22 m (70–75 ft) thick and the Ready Pay Member is about 70 m (230 ft) thick. The Box Member also becomes more calcareous westward with an increase in the concentration of limy nodules and thin beds of limestone.

The gradational nature of the contact between the two members of the Percha is well displayed at Bear Mountain, north of Silver City. The base of the Box Member is placed at the bottom of a 3 m (10 ft) unit of dark shale with limy nodules that are characteristic lithic components of the member. This unit yields a number of the brachiopods characteristic of the Box assemblage, including *Paurorhyncha* Cooper (1942), *Cyrtiorina* n. gen., *Syringospira* Kindle (1909), productids, and a few horn corals. Immediately below, at the top of the Ready Pay, is about 6 to 9 m (20–30 ft) of dark gray to black, non-calcareous, unfossiliferous shale. But below this unit, and above the main mass of the black Ready Pay shale, is about 3 to 4 m (10–15 ft) of gray, slightly calcareous shale with a few calcareous nodules that contain *Syringospira* and *Paurorhyncha*.

The Box Member is disconformably overlain by Mississippian strata. In some places, as at the type section described by Stevenson (1945), the basal Mississippian strata are yellowish-weathering, calcareous siltstones with phosphate pebbles, conodonts and trace fossils (including *Zoophycos* Massalongo (1855)). In

Table 6.—Brachiopods of the Percha Formation (Ready Pay Member) (+ = especially important elements).

+	<i>Lingulipora porifera</i> new species
+	<i>Retichonetes obscurus</i> new species
+	<i>Paurorhyncha cooperi</i> Stainbrook
	<i>Petasmaria patens</i> new genus and species
+	<i>Syringospira prima</i> Kindle
	<i>Cyrtiorina kindlei</i> (Stainbrook) [new genus]

other places, the nodular limestone of the Lower Mississippian Caballero Formation lies directly on the Box Member. Usually, a lag concentrate or pebbly conglomerate bed can be found at the contact and this zone has yielded early Mississippian (late Kinderhookian) conodonts in many places.

FOSSIL CONTENT AND DISTRIBUTION

The Box Member has yielded a diversified assemblage of invertebrate fossils, of which the majority are brachiopods. However, there are horn corals, bryozoans, molluscs (including pelecypods, gastropods,

cephalopods and scaphopods), *Hexacrinus* Austin and Austin (1844) and echinoderm debris. All the samples processed for conodonts proved to be barren thereof.

Most species of the Box Member range from top to bottom. Some apparent exceptions were noted, however. *Syringospira prima* Kindle (1909), which is present in the uppermost part of the Ready Pay, is most common in the bottom few m of the Box Member. Productids are extremely abundant and varied in the lower 6 to 9 m (20–30 ft) in the area around Silver City. The lower part of the member also contains abundant *Cyrtiorina* and *Paurorhyncha cooperi* Stainbrook (1947); and *Composita bellula* Stainbrook (1947) seems to be limited to the lower quarter of the Box Member of the Percha.

In many sections, the size of the individuals increases upward through the member, although the number of specimens decreases accordingly. One particularly distinctive species, *Paurorhyncha cooperi* Stainbrook (1947), was collected from the upper Ready Pay Member but ranges through the Box Member and was found within 25 cm of the top at one locality east of Kingston, New Mexico.

Table 7.—Brachiopods of the Percha Formation (Box Member) (+ = especially important elements).

<i>Lingula</i> species 1
<i>Lingula</i> species 2
<i>Orbiculoides</i> species 2
<i>Petrocrania ourayensis</i> (Kindle)
+ <i>Schizophoria australis</i> Kindle
+ <i>Thiemella platys</i> new species
+ <i>Schuchertella percha</i> (Stainbrook)
<i>S. resupinata</i> new species
+ <i>Retichonetes obscurus</i> new species
+ <i>R. perchaensis</i> new species
+ <i>Acanthatia nupera</i> (Stainbrook)
+ <i>Leioproductus plicatus</i> (Kindle)
<i>L. defessa</i> (Stainbrook)
<i>L. coloradensis</i> (Kindle)
<i>L. pauperculus</i> new species
+ <i>L. varispinosus</i> (Stainbrook)
+ <i>Galeatella galeata</i> Muir-Wood and Cooper
+ <i>Planoproductus hillsboroensis</i> (Kindle)
+ <i>Laminatia laminata</i> (Kindle)
+ <i>Sentosia praecedens</i> (Stainbrook)
+ <i>S. praecursor</i> (Stainbrook)
+ <i>S. spinigera</i> (Kindle)
+ <i>Ptychomalotoechia sobrina</i> (Stainbrook)
+ <i>Trifidorostellum obscurum</i> new species
<i>Camarotoechia?</i> species
+ <i>Paurorhyncha cooperi</i> Stainbrook
<i>Eoparaphorhynchus mclareni</i> Sartenaer
+ <i>Porostictia perchaensis</i> (Stainbrook)
+ <i>Petasmaria compacta</i> new genus and species
+ <i>P. multicosta</i> new species
+ <i>P. patens</i> new species
+ <i>Athyris transversa</i> (Stainbrook)
+ <i>Composita bellula</i> Stainbrook
+ <i>Ambocoelia capillata</i> new species
+ <i>Strophopleura notabilis</i> (Kindle)
<i>Cyrtospirifer? animasensis</i> (Girty)
+ <i>Cyrtospirifer convexus</i> new species
+ <i>C. rotundus</i> new species
• <i>Hispidaria posterogranulosa</i> new genus and species
• <i>H. spinosa</i> new species
• <i>Cyrtiorina kindlei</i> (Stainbrook) [new genus]
• <i>Syringospira prima</i> Kindle
• <i>Ioryniferella spinosa</i> (Kindle)
• <i>Oiosia putilla</i> (Stainbrook) [new genus]

BRACHIOPOD ASSEMBLAGE OF THE BOX MEMBER

This rich and diversified assemblage consists of 30 genera and 44 species, of which 25 genera and 32 species are characteristic. Many of the species were described by Kindle (1909) and Stainbrook (1947) and most of the productid genera were established by Muir-Wood and Cooper (1960). However, four new genera are described here: *Petasmaria*, *Hispidaria*, *Cyrtiorina*, and *Oiosia*. In addition, 12 new species are described.

AGE OF THE BOX MEMBER

The lower limit on the age of the Box fauna, as discussed above, is suggested by the occurrence of goniatites of the upper *Platyclymenia* Zone. The brachiopod fauna is definitely younger than that described from the West Range Limestone (Johnson *et al.*, 1969) and is older than uppermost Devonian assemblages in the Louisiana Limestone and correlative units in western North America. Sartenaer (1969) shows ranges for Famennian rhynchonellid genera that indicate an age no older than the upper *Platyclymenia* Zone for the combination of genera found in the Box Member. This, of course, agrees with the meager goniatite data.

On the mistaken notion that the Box Member was Mississippian, Stainbrook (1947) supplied several of the productids with Mississippian generic names and also included in his faunal list some float specimens,

such as *Leptagonia* M'Coy (1844) and *Buxtonia* Thomas (1914) from the overlying Mississippian and Pennsylvanian. The productids all proved to be productellids and are Devonian in age.

The mutual occurrence of *Paurorhyncha* Cooper (1942), *Porostictia* Cooper (1955), *Ptychomalotoechia* Sartenaer (1961a), and *Trifidorostellum* Sartenaer (1961a) suggests to us that the age of the Box fauna is probably restricted to the *Clymenia* Zone, in a general way (Text-fig. 8). This is equivalent to a range from the upper part of the *styriacus* Zone to the middle part of the *costatus* Zone, in terms of the conodonts.

Bryozoans from the Box Member were described by Fritz (1944). All the species were described as new and were assigned to seven genera. Because of a lack of comparably described assemblages, however, Fritz was unable to make any pertinent statement about the age of the Box bryozoans.

CONODONT BIOSTRATIGRAPHY

We are greatly indebted to the late J. W. Huddle, of the U.S. Geological Survey, who processed, identified and analyzed the conodonts in samples taken during this study. Because conodont faunas from the Devonian of New Mexico have not been discussed in any detail, we include Huddle's determinations and remarks here. As indicated in the foregoing biostratigraphic sections of this paper, the conodonts have provided valuable clues to the age and correlation of most of the Devonian units in New Mexico. In addition, many of the enigmatic sequences of black shale in the region have been placed in stratigraphic perspective as a result of Huddle's studies. Huddle's remarks are enclosed in quotation marks to distinguish them from our own interpretations.

We also acknowledge the assistance of A. G. Harris, of the U.S. Geological Survey, who brought some of the nomenclature up-to-date and sharpened some of the age assignments.

The collections are discussed below, from oldest to youngest, and their significance indicated. All collections that contain identifiable conodonts have been given U.S.G.S. locality numbers in the Silurian-Devonian catalogue (*e.g.*, USGS 9207-SD) and are stored with the USGS conodont reference set at the U.S. National Museum of Natural History in Washington, D.C.

CONODONTS FROM THE OÑATE FORMATION

Three of the four collections from the Oñate yielded conodonts and one of these contains *Polygnathus varcus* Stauffer (1940), indicating that the formation can be assigned to the *varcus* Zone in the broad sense.

Other evidence cited above leads us to place the Oñate in the middle *varcus* Subzone.

USGS locality 9312-SD (loc. 5221 herein), Oñate Formation, Mud Spring Mtns., basal 19 ft of the formation. Collectors: Cooper, Allen and Bowsher, 7/22/51.

	No. specimens
<i>Polygnathus linguiformis</i> Hinde (1879)	5
<i>Polygnathus varcus</i> s.l. Stauffer (1940)	5

"The presence of *P. varcus* suggests that this collection is not older than late Givetian. The oldest occurrences of this species in eastern U.S. are in the Centerfield Ls. in New York and the Beechwood Ls. in Indiana, and equivalent rocks in the middle West."

USGS locality 9208-SD (loc. 3023b herein), Oñate Formation, Johnson Park Canyon (Mockingbird Gap). Collectors: Bowsher and Allen.

	No. specimens
<i>Icriodus nodosus</i> (Huddle, 1934)	57
<i>Neoprioniodus</i> sp.	1
<i>Polygnathus linguiformis</i> Hinde (1879)	12
<i>Polygnathus</i> sp.	2

"*P. linguiformis* and *I. nodosus* both range from Middle Devonian to early Late Devonian. The abundance of *Icriodus* suggests a shallow-water environment."

USGS locality 9220-SD; Oñate Formation, 200 yd S. of bend in road in Johnson Park (Mockingbird Gap), northern San Andres Mtns.; 1 ft above base of formation. Collector: Bowsher, 1956.

<i>Icriodus</i> sp.	3 specimens
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"*Icriodus* is common only in the Devonian. Abundant in shallow-water deposits."

A fourth collection from the Oñate Formation in the Rhodes Canyon area, San Andres Mountains, yielded no conodonts.

Another collection, from fine-grained sandstone just above the Fusselman Dolomite near Lone Mountain, south of Hillsboro, yielded conodonts of about this same age. Although there was no lithic indication of the presence of the Oñate Formation when the area was examined, the conodonts indicate that a lag concentrate of Oñate age was preserved. This is one of two places in the region where we know of pre-Famennian conodonts from beds at the base of the Ready Pay Member that could have been reworked from older strata.

USGS locality 9214-SD; field No. M24(1). Lone Mtn. area; fine-grained sandstone 1-2 in above Fusselman Dolomite. Collectors: Cooper and Dutro, 3/24/64.

	No. of specimens
<i>Polygnathus linguiformis</i> Hinde (1879)	3
<i>Polygnathus tuberculatus</i> ? Bryant (1921)	1

"... the surfaces show only a few conodont fragments. *P. linguiformis* and *P. tuberculatus* range from Middle Devonian to early Frasnian."

CONODONTS FROM THE SLY GAP FORMATION

Three collections from the Sly Gap yielded only broken, unidentifiable fragments of conodonts to which Huddle could assign no age significance.

CONODONTS FROM THE CONTADERO FORMATION

Two collections from the Contadero yielded conodonts, assigned to the late Frasnian or, perhaps, early Famennian by Huddle. A reassessment of these faunas by Harris (oral commun., 1977) makes it likely that they represent the *Ancyrognathus triangularis* Zone (middle Frasnian). A more detailed knowledge of the ranges of conodont species in Frasnian strata of western Europe, developed during the past few years, makes possible this more precise dating. The clearly late Frasnian brachiopod assemblage of the Contadero is nicely bracketed by dated conodont collections.

USGS locality 9215-SD; San Andres Mtns., SE $\frac{1}{4}$ NE $\frac{1}{2}$ sec. 26, T. 11 S., R. 5 E.; type section of Sly Gap Fm. on Sheep Mtn.; basal beds of Contadero Fm. Collectors: Cooper and Dutro, 4/7/64.

	No. specimens
<i>Ancyrodella nodosa</i> Ulrich & Bassler (1926)	14
<i>Ancyrognathus</i> species	1
<i>Bryantodus</i> species	1
<i>Hibbardella</i> species	2
<i>Ligonodina</i> species	3
<i>Palmatolepis</i> species	17
<i>Polygnathus</i> species	16
<i>Poly. decorosus</i> ? Stauffer (1940)	11

"The fragments are too small to be certain, but it is probable that the following species are present: *Palm. subrecta* and *Polygnathus homoirregularis*." Harris indicates that the mutual occurrence of *Ancyrodella nodosa*, *Ancyrognathus* sp. and *Palm. subrecta* make an assignment to the *Ancyrognathus triangularis* Zone a reasonable one. According to Klapper (oral commun., 1981) the assemblage could range from the *Ancyrognathus triangularis* Zone through the *Palm. gigas* Zone; and a slightly younger age would fit better with the correlations based on brachiopods (Text-fig. 8). In any case, this appears to be a late Frasnian assemblage.

One collection made by R. H. Flower from 40–45 ft above the base of the Contadero in the Rhodes Canyon section (collection not numbered) contains a broken specimen of *Ancyrognathus*, probably *A. triangularis* Youngquist, according to Huddle (written commun., 1968).

CONODONTS FROM THE THOROUGHGOOD FORMATION

One collection from the thin remnant of Thoroughgood in Deadman Canyon, San Andres Mountains, yielded a few conodonts that are significant in that they suggest correlation with the basal Ready Pay Member to the west. The Famennian age of the brachiopods of both the Thoroughgood and Rhodes Canyon formations is not in doubt and this conodont date, although qualified because of poor preservation, provides a valuable link in the regional stratigraphic scheme.

[no locality number]. San Andres Range, Deadman Canyon; center NW $\frac{1}{4}$ SE $\frac{1}{2}$ sec. 12, T. 17 S., R. 3 E.; bed N (fish bed) of Thoroughgood Formation. Collectors: Cooper and Dutro, 4/9/64.

"There are broken and altered conodonts in the sandstone. The 5 recognizable fragments seem to be *Icriodus*, *Polygnathus*, perhaps *P. semicostatus*, and another species of *Polygnathus*."

Although Huddle did not venture an age assignment, *P. semicostatus* occurs in collections from USGS localities 9210-SD and 9213-SD, both of which were assigned an early Famennian age by Huddle (written commun., 1973). The species is long-ranging in the Famennian, but is unknown below the *rhomboidea* Zone.

CONODONTS FROM THE READY PAY MEMBER OF THE PERCHA SHALE

Perhaps the most significant contribution of the conodont studies of Huddle is the dating of the base of the Ready Pay Member. Three collections from the base of the member, two from near Wilson Ranch and one from the Cooks Range, indicate an early Famennian age.

Although ranges of some of the more distinctive species, in terms of conodont studies elsewhere, extend from the uppermost *Palmatolepis triangularis* Zone to the upper *Palmatolepis marginifera* Zone, overlapping ranges suggest that an assignment to the *Palmatolepis rhomboidea* Zone is reasonable. Two collections from the base of the black shale that overlies the Sly Gap Formation near Hermosa give a similar age assignment. As mentioned above, the base of the Thoroughgood in the San Andres Mountains can also be considered of about this age.

Three collections from black shale above the Oñate Formation in the southern Caballo Mountains yield conodonts of this same approximate age and can be interpreted to represent the Ready Pay. This provides a stratigraphic correlation between the type region of the Ready Pay to the west and the Famennian formations of the San Andres Range.

A final collection that contains conodonts of early Famennian age comes from the meter or so of black shale that overlies the Sly Gap Formation in Deadman Canyon in the Sacramento Mountains. As this collection also contains some reworked specimens of Frasnian species, it probably indicates that the shale was deposited during a period in the early Famennian when Sly Gap and Contadero strata were being eroded.

The species identified by Huddle (written commun., 1973; 1974), with their occurrences in the several collections from New Mexico, and the ranges of the species where known elsewhere, are shown in Table 8.

CONODONTS FROM BEDS OVERLYING THE DEVONIAN

Four collections from beds above the Devonian yield early Mississippian conodonts. Three of these are from the Caballero Formation in the Kingston-Silver City area. The Caballero contains a diversified upper Kinderhookian megafossil assemblage, so this conodont evidence is simply confirmatory. The fourth collection, however, from Deadman Canyon is from sandy beds above the Contadero and just below the Caballero. Similar sandy beds, with trace fossils including *Zoophycos*, are found elsewhere below the Caballero. This Mississippian collection is, therefore, helpful for dating this pre-Caballero unit.

Mississippian collections have been assigned numbers in the U.S. Geological Survey Upper Paleozoic catalogue (for example: USGS locality 25242-PC) and are stored with the conodont reference set in the United States National Museum of Natural History, Washington, D.C.

USGS locality 25242-PC; field No. M27; Kingston quad. (15'); near center SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 14, T. 16 S., R. 27 W.; 1-2 in fish tooth bed at base of Mississippian. Collectors: Cooper and Dutro.

	No. specimens
<i>Polygnathus inornatus</i> E. R. Branson (1934)	12
<i>P. longiposticus</i> Branson and Mehl (1934b)	1
<i>P. scobiniiformis</i> E. R. Branson (1934)	5
<i>P. symmetricus</i> E. R. Branson (1934)	3
<i>Pseudopolygnathus primus</i> Branson and Mehl (1934b)	3
<i>Siphonodella cooperi</i> Hass (1959)	12
<i>S. obsoleta</i> Hass (1959)	2
<i>Spathognathodus aculeatus</i> (Branson and Mehl, 1934a)	1

"All the conodonts in this collection are worn but they all indicate an age of middle or late Kinderhookian."

USGS locality 25243-PC; San Andres Mtns., Bear Canyon section; 10-15 ft above base of Caballero Fm. Collectors: Cooper and Dutro.

	No. specimens
<i>Apatognathus</i> sp.	1
<i>Elictognathus</i> sp.	1
<i>Gnathodus</i> sp.	4
<i>Hindeodella</i> sp.	4
<i>Ozarkodina</i> sp.	4
<i>Polygnathus allocotus</i> C. L. Cooper (1939)	1
<i>Poly. communis</i> Branson and Mehl (1934b)	10
<i>Poly. symmetricus</i> E. R. Branson (1934)	1
<i>Siphonodella crenulata</i> (C. L. Cooper, 1939)	5
<i>S. obsoleta</i> Hass (1959)	5
<i>Spathognathodus</i> sp.	4
<i>Synprioniodina</i> sp.	3

"The presence of *S. crenulata* indicates a late Kinderhookian age for the sample."

USGS locality 25244-PC; Silver City quad., Bear Mtn. section; bed E, nodules at base of Caballero Fm. Collectors: Cooper and Dutro.

	No. specimens
<i>Hindeodella</i> sp.	1
<i>Neoproniodus</i> sp.	1

USGS locality 25245-PC; San Andres Mtn., center NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 12, T. 17 S., R. 3 E.; Deadman Canyon section, bottom 2 ft of bed O. Collectors: Cooper and Dutro.

	No. specimens
<i>Siphonodella</i> sp.	5
<i>Pseudopolygnathus</i> sp.	1
<i>Polygnathus</i> sp.	1

"This collection is early Mississippian in age."

Additional information on conodonts of these intervals may be found in W. I. Anderson (1966), C. L. Cooper (1931), Ellison (1950), and Ethington (1965).

GEOLOGIC HISTORY

The foregoing discussion of the stratigraphy and biostratigraphy of the Devonian of south-central and southwestern New Mexico suggests that a sequence of geological events can be described with some confidence.

During the late Middle Devonian (late Givetian) the seas again covered southern New Mexico after a long period during which erosion of early Paleozoic rocks had taken place. The Oñate Formation represents these first, shallow marine deposits, which were unconformably deposited on an irregular surface that was developed on Silurian and Upper Ordovician rocks.

Fine-grained, dolomitic clastic rocks characterize the Oñate, which also contains many trace fossils and evidence of extensive bioturbation. The thin sequence in

Table 8.—Conodont occurrences in the basal Percha Formation, southwestern New Mexico, and related strata. USGS locality 9221-SD, base of Ready Pay Member, Cooks Range; USGS locality 9212-SD, base of Ready Pay Member, 0.75 mi SW of Wilson Ranch, Hillsboro area; USGS locality 9216-SD, base of Ready Pay Member, just W. of Wilson Ranch, Hillsboro area; USGS locality 9211-SD, base of Ready Pay Member, Hermosa A section; USGS locality 9217-SD, base of Ready Pay Member, Hermosa B section; USGS locality 9213-SD, black shale near Nakaye Mines, southern Caballo Range; USGS locality 9210-SD, black shale at Red House Mountain, southern Caballo Mountains; USGS locality 9207-SD, black shale at top of section, Deadman Canyon, Sacramento Mountains. An asterisk marks each species that may have been reworked from older strata.

Conodont Taxa	U.S. Geological Survey Localities							
	9221-SD	9212-SD	9216-SD	9211-SD	9217-SD	9213-SD	9210-SD	9207-SD
<i>Acodina</i> sp.					1			
<i>Ancyrodella curvata</i> (Branson and Mehl, 1934)* ..				1				
<i>Ancyrodella nodosa</i> Ulrich and Bassler (1926)* ..		1 ?						
<i>Ancyrodella</i> sp.* ..	1				1			1
<i>Ancyrognathus asymmetricus</i> (Ulrich and Bassler, 1926)* ..	4							
<i>Ancyrognathus</i> sp.* ..						3	1	1
<i>Bellodella</i> sp.			1					
<i>Bryantodus collingatus</i> (Bryant, 1921) ..			1					1 cf
<i>Bryantodus</i> sp.	2		10	3	1	1	1	
<i>Diplododella</i> sp.							1	
<i>Hibbardella</i> sp.			2				1	
<i>Hindeodella</i> sp.	1		2		2	8	20	
<i>Icriodus</i> sp.	4		4		1	3	2	
<i>Ligonodina</i> sp.			1				2	
<i>Lonchodina</i> sp.			4			1		
<i>Neopriomodus</i> sp.	1		4					
<i>Ozarkodina</i> sp.	1					4	2	
<i>Palmatolepis</i> aff. <i>P. circularis</i> Szulczewski (1971) ..					1			
<i>Palmatolepis crepida</i> ? Sanneman (1955) ..						2		
<i>Palmatolepis gigas</i> Miller and Youngquist (1947)* ..			3 ?					
<i>Palmatolepis glabra</i> Ulrich and Bassler (1926) ..	15					22		3
<i>Palmatolepis glabra acuta</i> Helms (1963) ..							1	
<i>Palmatolepis glabra glabra</i> Ulrich and Bassler (1926) ..							10	
<i>Palmatolepis glabra lepta</i> Ziegler and Huddle (1969) ..		3					4	
<i>Palmatolepis glabra prima</i> Ziegler and Huddle (1969) ..	15		5	6	8			
<i>Palmatolepis glabra pectinata</i> Ziegler (1962) ..		56					14	
<i>Palmatolepis minuta loba</i> Helms (1963) ..	2							
<i>Palmatolepis minuta minuta</i> Branson and Mehl (1934) ..	3	7			3			
<i>Palmatolepis perlobata</i> Ulrich and Bassler (1926) ..	7 ?			2				
<i>Palmatolepis quadrantinodosa</i> Branson and Mehl (1934) ..	28							
<i>Palmatolepis quadrantinodosa inflexa</i> Müller (1956) ..						2 ?		
<i>Palmatolepis quadrantinodosalobata</i> Sanneman (1955) ..	7 ?			1	2			
<i>Palmatolepis subrecta</i> Miller and Youngquist (1947) ..			9 ?	2	4	6		
<i>Palmatolepis superlobata</i> Branson and Mehl (1934) ..	3 ?	1 ?		2			16	
<i>Palmatolepis tenuipunctata</i> Sanneman (1955) ..							2	
<i>Palmatolepis triangularis</i> Sanneman (1955) ..					1			
<i>Palmatolepis</i> sp.							3	
<i>Polygnathus brevilaminus</i> Branson and Mehl (1934) ..			2					
<i>Polygnathus decorosus</i> Stauffer? (1938) ..			42	12	18			
<i>Polygnathus glaber</i> Ulrich and Bassler (1926) ..	12			1			1	1
<i>Polygnathus homoirregularis</i> Ziegler? (1962) ..	16							
<i>Polygnathus linguiformis</i> Hinde (1879)* ..	1 ?	1 ?	1					
<i>Polygnathus nodocostatus</i> Branson and Mehl (1934) ..	9					17		
<i>Polygnathus normalis</i> Miller and Youngquist (1947) ..	5 ?			1 ?		1		
<i>Polygnathus perplexus</i> Thomas (1949) ..		4						
<i>Polygnathus semicostatus</i> Branson and Mehl (1934) ..						27	1	2
<i>Polygnathus</i> sp.	7	2			1			7
<i>Polylophodonta confluens</i> (Ulrich and Bassler, 1926) ..	3							
<i>Polylophodonta pergyrata</i> (Holmes, 1928) ..							1	
<i>Polylophodonta</i> sp.	1						1	
<i>Prioniodonta dialata</i> (Bryant, 1921) ..		3				1		
<i>Spathognathodus regularis</i> (Branson and Mehl, 1934) ..								8
<i>Synprioniodina</i> sp.			4					

the northern part of the San Andres Mountains contains abundant specimens of *Icriodus* Branson and Mehl (1938), a conodont that characterizes shallow-water environments (Huddle, written commun., 1974). The general thickening of the sequence southward in the San Andres Mountains, and the increase in the amount of shale, suggests deepening of the original basin in that direction. The Canutillo Formation (Nelson, 1940) of the Franklin Mountains is of probable Middle Devonian age and could be a deeper-water equivalent of the Oñate Formation.

West of the Rio Grande in the Mimbres Range, the type area of the Percha Shale, there is little evidence of pre-Famennian Devonian deposition in New Mexico. However, in the Swisshelm and Pedregosa Mountains of southeastern Arizona, the lower part of the Swisshelm Formation is an equivalent of the Oñate (Epis *et al.*, 1957).

According to Epis *et al.* (1957, p. 2255–2256) two regional pictures can be developed for the Devonian deposits of Arizona and New Mexico. They discuss these briefly and prefer the simpler one, in which the Percha Shale is interpreted as a deeper-water facies of the Sly Gap and its equivalents. Unfortunately, our analysis of the faunas and age of the Devonian sequence demonstrates that the Percha is, indeed, younger than the Oñate-Sly Gap-Contadero sequence. Consequently, the more complex history, involving onlap around a positive area in southwestern New Mexico, is the more likely explanation.

Johnson (1970) presented an intriguing series of arguments for progressive onlap of the continental “backbone” during the Taghanician Stage. Insofar as New Mexico and Arizona are concerned, the evidence for onlap of this age is overwhelming, with the basal Oñate strata lying unconformably on formations as old as the El Paso (in Arizona) and as young as the Fusselman (in most parts of the San Andres and Sacramento Mountains). However, this region shows no definite evidence of progressive overlap unless it be in the main outcrop belt of the Martin Group where no demonstrably Middle Devonian marine faunas have been found. However, detailed stratigraphic and paleogeographic studies by Teichert (1965) demonstrate Frasnian onlap of the Defiance uplift from the south and southwest. It is possible that some part of the dolomite units at the base of the Jerome Member may be equivalents of the Oñate Formation, but no fossils have been reported that would verify such a relationship.

The succeeding strata of the Sly Gap Formation represent renewed marine deposition in an open shelf environment, after a depositional hiatus. Only fine-grained

clastic material reached the shelf during the middle Frasnian, as the Sly Gap is essentially a calcareous clay shale unit. Limestone nodules are characteristic of the Sly Gap, which has a diverse marine invertebrate fauna including both solitary and compound rugose corals. The hiatus is inferred because of the absence of early Frasnian fossils, approximately of the Shell Rock–Waterways interval of Iowa and western Canada.

In addition, black shale including phosphatic lag deposits at the base of the Sly Gap at Alamo Peak and Bear Canyon (Pl. A, fig. 2) and clastic strata at the base of the Sly Gap at Hermosa and Rincon provide sedimentologic evidence of this hiatus. Consequently, the contact between the Oñate and the Sly Gap must be a regionally disconformable one.

The Contadero Formation indicates an influx of silt and fine sand in the later Frasnian and a decrease in limestone, although calcareous beds do occur. The marine invertebrate fauna is less diverse than that of the Sly Gap, but it also includes rugose corals.

Deposition from the Sly Gap into the Contadero must have been essentially continuous, although there are many discontinuities between individual beds. Sediment accumulation was relatively slow, apparently, for much of late Frasnian time is recorded in a few tens of meters of strata. By way of contrast, many hundreds of meters of beds were deposited in western Utah and eastern Nevada during this same time interval.

Another major depositional hiatus seems to have occurred in latest Frasnian and earliest Famennian time. Rather than being an episode of non-deposition, this must have been a period of slight uplift and erosion. The sections in the San Andres Mountains record removal of varying amounts of Frasnian strata before deposition of the Famennian.

Marine onlap in the early Famennian (about *rhomboidea* Zone time) is recorded in many places by sandy phosphatic lag deposits containing conodonts representing this zone. This was the time of initiation of Percha deposition in southwestern New Mexico. It was also the time of deposition of the sandy Thoroughgood Formation in the San Andres Mountains and black shale in the southern part of the Sacramentos.

The Percha beds record deposition in a deep basin resulting in the black, essentially unfossiliferous, shales of the Ready Pay Member. Shallow-water, more normal, marine shelf conditions are recorded by the calcareous shale and nodular limestone of the overlying Box Member with its diverse fauna of brachiopods, solitary rugose corals, bryozoans and molluscs. Gradational stratigraphic relationships between the two

members indicate continuous deposition through middle and early late Famennian time, with a progression from deeper water to shallow-shelf conditions.

In the latest Famennian there was again a period of slight uplift during which the Devonian beds were removed to various depths throughout the region. Subsequently, middle and late Kinderhookian strata were deposited unconformably on Devonian beds as young as the Box Member, in the Hillsboro area, and as old as the Oñate Formation, in the southern part of the Sacramento Mountains.

Table 9.—Brachiopods of the Independence Shale described in this paper.

<i>Schizophoria amanaensis</i> Stainbrook
<i>Stainbrookia infera</i> (Calvin) [new genus]
<i>Cariniferella costellata</i> new species (= <i>C. iowensis</i> part)
<i>Strophonelloides deeringi</i> Stainbrook
<i>Nervostrophia extensa</i> new species
<i>Nervostrophia multinervosa</i> Stainbrook
<i>Pseudodouvillina euglyphea</i> Stainbrook
<i>Sulcatostrophia calvini</i> (Miller)
<i>Douvillinaria variabilis</i> (Calvin)
<i>Floweria transversalis</i> new genus and species
<i>Productella rugatula</i> Stainbrook
<i>Devonoproductus vulgaris</i> Stainbrook
<i>Gypidula cornuta</i> Fenton and Fenton
<i>Gypidula stainbrookii</i> new species
<i>Costatrypa varicostata</i> (Stainbrook)
<i>Iowatrypa americana</i> (Stainbrook)
<i>Spinatrypa trulla</i> (Stainbrook)
<i>Acutatheca propria</i> Stainbrook
<i>Thomasaria altumbona</i> Stainbrook
<i>Cyrtina inulta</i> Stainbrook

Table 10.—Brachiopods of the Cerro Gordo Member and Cedar Valley Formation, described in this paper.

<i>Schizophoria lata</i> Stainbrook [Cedar Valley Formation]
<i>Schizophoria iowensis</i> (Hall)
<i>Strophonelloides hybridus</i> (Hall & Whitfield) [see <i>S. dorsoconvexus</i>]
<i>Douvillina arcuata</i> (Hall)
<i>Floweria prava</i> (Hall) [new genus]
<i>Eostrophalosia rockfordensis</i> (Hall & Clarke)
<i>Gypidula cornuta</i> Fenton and Fenton
<i>Calvinaria bransonii</i> Stainbrook
<i>Pseudoatrypa devoniana</i> (Webster)
<i>Tenticospirifer cyrtinaformis</i> (Hall & Whitfield)
<i>Cranaena calvini</i> (Hall & Whitfield)
<i>C. navicella</i> (Hall)

BRACHIOPODS FROM IOWA

In the course of describing the Frasnian and late Middle Devonian brachiopods from New Mexico, it was necessary to discuss or describe a number of species from correlative strata in Iowa. In his paper on the Independence Shale brachiopods, Stainbrook (1945) described 35 genera and 40 species. We have redescribed about half of these taxa and have added two new genera and four new species.

Eleven species from the Hackberry Formation (Cerro Gordo Member) and one from the Cedar Valley Formation are also redescribed herein.

SYSTEMATIC PALEONTOLOGY

INTRODUCTION

Philosophical Considerations

The species named and delineated here are morphospecies in the sense of Hoover (1981). No other approach to presenting the wealth of morphologic detail appears practical. As discussed above, most of the New Mexico Devonian brachiopod genera have already been distinguished. This is especially true of the Frasnian Sly Gap assemblage, for which only one new genus is established here. Consequently, in order to support detailed biochronologic, biostratigraphic, and biogeographic conclusions, every attempt was made to separate morphospecies on consistent differences, no matter how minute. This may seem to be an ultimate "splitting" technique, but we present our results, unabashedly, with the full understanding that most fossil assemblages fall far short of reflecting the biologic diversity of the geologic interval represented by the paleontologic sampling.

The species names are merely conveniences for discussing clusters of morphologic variability within what are, for the most part, well-established generic concepts. When similar studies of comparably rich assemblages in various parts of the world are completed, the paleontologist will be ready to start formulating sound biologic and geologic syntheses. This incompleteness has not prevented us from drawing preliminary conclusions concerning the age, correlation and biogeographic significance of the New Mexico Devonian brachiopods. Nor have we shied away from presenting a Devonian geologic history of the region that is now south-central New Mexico. All these ideas must be considered only geologic and biologic hypotheses, to be tested by additional work in New Mexico and elsewhere.

Format

Suprageneric hierarchies are standard for brachiopod systematics and follow, for the most part, those of the brachiopod volume of the *Treatise on Invertebrate Paleontology* (Williams *et al.*, 1965). Minor changes were made where we consider earlier workers in error. One clarification deserves special mention. Generic and suprageneric categories that have classically been attributed to Schuchert and LeVene (1929) are herein attributed solely to Schuchert who wrote (1929, p. 4), "The senior author presents a new classification (p. 10) built upon the older ones . . ."

Simple generic and specific diagnoses are given for most of the taxa, and detailed descriptions are given for the new ones. Variability of morphologic features is presented both qualitatively and quantitatively, where feasible. Some single specimens or small samples, however, are so distinct morphologically that they are described as new.

The Percha brachiopod assemblage is well-known and extensively described by earlier workers. We discuss all the taxa known to us, but illustrate here only those species that we describe as new or redescribe on the basis of new material or additional observations. For illustrations of the better-known Percha genera and species, the reader is directed to Girty (1900), Kindle (1909), Stainbrook (1947), Cooper (1942, 1954, 1955) and Muir-Wood and Cooper (1960). Some of the brachiopods discussed by Stainbrook (1947) led him to erroneous conclusions about the age of the Percha. We list and discuss these taxa at the end of the systematics section, and give our views and interpretations of each.

Terminology

Most of the descriptive terms used here are defined in the glossary of the brachiopod volume of the *Treatise* (Williams *et al.*, 1965). Special terminology for the orthoids and pentameroids is that of Schuchert and Cooper (1932), and productoid terminology follows Muir-Wood and Cooper (1960).

The Collection

The collection on which this monograph is based was brought to the U.S. National Museum of Natural History by many individuals. The earliest acquisitions were made by the U.S. Geological Survey (G. H. Girty, L. C. Graton, S. Paige and N. H. Darton, collectors). A collection from the Percha Shale at Lake Valley was presented to the U.S. Geological Survey by Frank Springer.

Cooper was introduced to this prolific Devonian se-

quence in 1939 when he and Dr. Josiah Bridge of the U.S. Geological Survey visited the fine exposures of Percha Shale at the abandoned settlement at Georgetown, New Mexico. In 1947, E. L. Yochelson and Cooper visited Dr. C. C. Branson, who was surveying in the Sacramento and San Andres Mountains, and collected from several canyon exposures, especially at Sly Gap, then difficult of access. Dr. Branson from time to time presented the Museum with small lots of Sly Gap fossils.

In 1947, Frank V. Stevenson presented his extensive collection of New Mexico Devonian fossils to the Museum.

In 1948, Arthur L. Bowsher and W. T. Allen of the U.S. National Museum mapped and made collections in the Sacramento Mountains and Silver City area. This was followed by further collecting in 1952. In 1956, Bowsher, Dutro, and Cooper, joined by Dr. Rousseau Flower from the New Mexico Bureau of Mines and Mineral Resources, studied and collected in the San Andres and Sacramento Mountains. In 1964, Dutro and Cooper measured sections in the Sacramento and San Andres Mountains and westward to Silver City and made additional collections.

Dr. L. A. Nelson of El Paso presented the Museum with choice specimens from the Sly Gap and Percha formations. Mr. C. O. Leverson, avid collector of the Iowa Devonian, presented the Museum with rare specimens of fossils from the Cerro Gordo Member that are illustrated herein.

Merrill A. Stainbrook, then at Texas Tech. at Lubbock, Texas, presented the Museum with fine specimens of Independence Shale fossils, some of which are illustrated in this monograph. After his death, the University of Iowa presented Stainbrook's collections of Sly Gap and Percha specimens to the Museum.

Collections made at the same locality in different years generally have received different locality numbers.

Collections at localities listed in Appendix 3 for which no collectors' names are given were made by the authors.

Type Repository

All the type specimens cited in the following section are identified as USNM specimens, deposited in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, U.S.A. Some of the types originally illustrated by Stainbrook also bear an M.A.S. number; this refers to the M. A. Stainbrook collection, now also deposited in the U.S. National Museum of Natural History.

Measurements

Measurements given herein are standard for brachiopod systematics, unless otherwise qualified, and are given in millimeters. The use of an asterisk in the tables of measurements indicates a number derived from the half-measurement of a bilaterally symmetrical feature. A plus sign after a number indicates that the specimen is broken and that the true measure is somewhat greater.

Class **INARTICULATA** Huxley, 1869

Order **LINGULIDA** Waagen, 1885

Superfamily **LINGULACEA** Menke, 1828

Family **LINGULIDAE** Menke, 1828

Genus **BARROISELLA** Hall and Clarke, 1892

Barroisella species

Plate 1, figures 1, 2

Two specimens of a small, narrowly elongate linguloid are referred to this genus because of the internal markings on the ventral valve. One (USNM 200818a) is a small dorsal valve. The second (USNM 200818b) specimen is a larger ventral valve exhibiting only the interior.

The ventral valve is more than twice as long as wide and tapers at both ends. The sides are gently rounded. Internally the pedicle groove is long and deep. Two pallial trunks diverge from the anterior part of the pedicle groove. On the outside of the divergent grooves is an elongate muscle scar. Other indefinite muscle scars appear at above midvalve.

The dorsal valve is from a smaller individual but it has essentially the same proportions as the ventral valve. Some of the exterior is preserved and shows fine concentric lines. The posterior part is exfoliated but the specimen is too young to show any interior details.

Measurements (in mm).—USNM 200818b (ventral valve): length 6.7, width 3.4. USNM 200818a (dorsal valve): length 5.0, width 2.5.

Diagnosis.—Small *Barroisella* having the length more than twice the width.

Stratigraphic occurrence.—Contadero Formation.

Locality.—524o.

Types.—Figured Specimens: USNM 200818a, b.

Discussion.—Specimens of linguloids having essentially the same size and proportions of this Contadero species occur in late Middle and early Late Devonian sediments of the eastern United States but none of them has been determined to be *Barroisella*.

Genus **LINGULA** Bruguière, 1797

Lingula species 1

Two crushed specimens are all of this genus that have so far been found in the Percha Formation (Box Member). One specimen (USNM 200834) is 16 mm long and about 10 mm wide and is ornamented by very closely spaced raised concentric lines.

Stratigraphic occurrence.—Percha Formation (Box Member).

Locality.—506b.

Types.—Described Specimen: USNM 200834.

Lingula species 2

Another linguloid specimen (USNM 200839) is similarly crushed, and much of the shell is torn away. It is 13 mm long and 9 mm wide. Bits of shell retained are ornamented with concentric lines, coarser and less crowded than those of *Lingula* sp. 1.

Stratigraphic occurrence.—Percha Formation (Box Member).

Locality.—507c.

Types.—Described Specimen: USNM 200839.

Lingula species 3

The single dorsal valve (USNM 207697) is small (length 12 mm and width about 7 mm), with well-rounded sides and rounded anterior margin; posterior margin narrowly rounded. Its anterior half is marked by four strong, distant concentric lines. The posterior half is without strong concentric marks. The species has some resemblance to *Lingula complanata* H. S. Williams (1882) of the Ithaca Formation of New York, but has stronger concentric markings and is more narrow posteriorly.

Stratigraphic occurrence.—Oñate Formation.

Localities.—529n, o.

Types.—Described Specimen: USNM 207697.

Lingula species 4

Two specimens measure about 10 mm in length and 5 mm in width, tapering at both anterior and posterior; sides gently rounded. These specimens are unlike *Lingula* sp. 3 in their more acuminate ends and gently rounded sides. This species is shaped somewhat like *L. ligea* Hall, 1860b from the Middle and lower Upper Devonian rocks of New York.

Stratigraphic occurrence.—Oñate Formation.

Locality.—529r.

Types.—Described Specimens: USNM 207698a, b.

Genus **TRIGONOGLOSSA** Dunbar and
Condra, 1932

Trigonoglossa? species

This large, triangular specimen is badly crushed and marked by strong, concentric lines, which are elevated near the anterior.

Stratigraphic occurrence.—Oñate Formation.

Locality.—526h.

Types.—Described Specimen: USNM 207695.

Genus **LINGULIPORA** Girty, 1898

Lingulipora porifera new species

Plate 39, figures 52–56

Small, longitudinally elliptical in outline; length approximately twice width; posterior margin forming angle of about 70 degrees; sides slightly convex, nearly parallel; anterior margin broadly rounded; anterolateral extremities narrowly rounded. Surface marked by unequal, concentric lines closely crowded on sides, more widely spaced anteriorly on body of shell. Inner layer of shell punctate, with coarse punctae scattered on umbonal region anterior to beak, but fine and crowded punctae on remainder of shell (USNM 200899k).

Ventral valve most convex medially with sides sloping moderately to margins in anterior half but more steeply in posterior where valve is deepest; lateral profile broadly and gently convex, maximum height occurring about one-third distance from beak; umbonal region subcarinate and extending posteriorly to sharp and narrow beak. Propareas prominent, pedicle groove deep and narrow; interior details indistinct.

Dorsal valve in lateral profile with maximum height in umbonal region, descending abruptly posteriorly but gently to anterior margin; anterior profile forms broad low triangle roundly subcarinate at apex. Beak region roundly angular. Posterior margin thickened on inside of valve; interior with low, faint median ridge slightly posterior to midvalve.

Measurements (in mm).—

	ventral valves			dorsal valves		
	USNM 200899a	USNM 200899d	USNM 200899j	USNM 200899e	USNM 200899f	USNM 200899h
Length	5.0	7.8	5.0	5.7	4.8	4.4
Width	2.9	3.5	2.6	3.0	2.3	2.5

Diagnosis.—Small *Lingulipora* having nearly parallel sides, length about twice width and subcarinate umbonal regions.

Stratigraphic occurrence.—Percha Formation (basal Ready Pay Member).

Locality.—3037.

Types.—Holotype: USNM 200899b. Figured Paratypes: USNM 200899d, f, h, and j. Unfigured Paratypes: USNM 200899a, c, g, i.

Discussion and comparison.—This species differs from *Lingulipora williamsana* Girty (1898) from the Chattanooga Shale in its larger size, longer valves and more nearly parallel sides. Girty's is the only species of this genus so far described from this country. In his discussion of the genus *Lingulipora*, Girty (1939, p. 60) found it confusing that punctae seem to appear sporadically in some linguloid species and in the genus *Trigonoglossa* Dunbar and Condra (1932), a fact that led him to have doubts about the validity of *Lingulipora*. It is true that little is known of the role and occurrence of punctae in the inarticulate brachiopods, especially the linguloids. *Bistramia* Hoek (1912) from the Devonian of Bolivia is strongly punctate. Therefore, we recognize *Lingulipora*, because the punctae are a convenient means of distinguishing this Ready Pay species.

Order **ACROTRETIDA** Kuhn, 1949

Suborder **ACROTRETIDINA** Kuhn, 1949

Superfamily **DISCINACEA** Gray, 1840

Family **DISCINIDAE** Gray, 1840

Subfamily **ORBICULOIDEINAE** Schuchert, 1929

Genus **ORBICULOIDEA** d'Orbigny, 1847

Orbiculoidea species 1

Plate 1, figures 3–6

A single large dorsal valve (USNM 200817a) referable to *Orbiculoidea*, taken from the Contadero Formation, is broadly elliptical, wider than long, and irregularly conical. In lateral profile the cone is asymmetrical, the anterior slope long and convex, the posterior slope short and precipitous, probably somewhat deformed. The apex of the cone is located about three-fourths the valve length from the anterior margin. In anterior profile the specimen forms a low arch. The apex is smooth but the remainder of the shell is marked by fine concentric lines and faint radial costellae.

A second specimen (USNM 200817b), smaller than the former and probably a young shell of the same species, is subcircular, a low cone. The ventral valve is concave and has a large foramen.

Measurements (in mm).—USNM 200817a: length 13.7, width 17.4 (based on the half measure); height of cone 5.6. USNM 200817b: length 6.5, width 6.0; height 2.0.

Stratigraphic occurrence.—Contadero Formation (lower 5 ft).

Locality.—524o.

Types.—Figured Specimens: USNM 200817a, b.

Orbiculoidea species 2

A single dorsal valve from the Percha Formation (Box Member) at locality 506b is so poorly preserved that it cannot be identified specifically. It is 15 mm in diameter, a low cone with most of the posterior third eroded away. The surface is marked by broad concentric undulations.

Types.—Described Specimen: USNM 200863.

Suborder **CRANIIDINA** Waagen, 1885

Superfamily **CRANIACEA** Menke, 1828

Family **CRANIIDAE** Menke, 1828

Genus **PHILHEDRA** Koken, 1889

Philhedra species

Plate 1, figure 22

A single specimen was taken with *Rhipidomella* at Sly Gap. It is small, 8.6 mm long by about 9 mm wide. The sides are well rounded, the anterior margin narrowly rounded. The posterior margin is truncated. The smooth apex is located about one-third the length from the posterior margin. Costellae measure four to the millimeter at the front margin.

Stratigraphic occurrence.—Sly Gap Formation in beds below *Macgeea* Webster (1889b), at the base of the formation.

Locality.—506j.

Types.—Figured Specimen: USNM 203534.

Genus **PETROCRANIA** Raymond, 1911

Petrocrania ourayensis (Kindle)

Plate 1, figures 23–26

Crania ourayensis Kindle, 1909, p. 391, p. 15, pl. 1, figs. 2, 2a.

Petrocrania ourayensis (Kindle) Stainbrook, 1947, p. 302, pl. 45, fig. 10.

This uncommon species, like all members of the genus, is variable with its shape and profile depending on the contours of its host. Specimens often reflect, on the dorsal valve, the ornamentation of the host. The species selects a variety of hosts of which *Leio-productus coloradoensis* (Kindle) and *Schizophoria australis* Kindle are favorites.

Diagnosis.—Fairly large *Petrocrania*, subcircular cones with apex slightly posterior of the center.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, q; 507m, n, o; 509b, c, e; 527a, d; 3026, a.

Types.—Figured Hypotypes: USNM 200826a, 200827.

Petrocrania species 1

Plate 1, figure 7

This is a small conical dorsal valve perched on the posterolateral margin of *Hadrorhynchia* and thus somewhat misshapen. The anterior slope is long and convex; the posterior slope is short, steep and nearly flat. The apex is about three-quarters the length from the anterior margin. The surface is marked by fairly strong concentric lines.

Measurements (in mm).—Length 9.2, width 11.5, height 3.0.

Stratigraphic occurrence.—Oñate Formation.

Locality.—523d.

Types.—Figured Specimen: USNM 201153.

Petrocrania specifically unidentified

Plate 1, figures 8, 9; plate 38, figure 24

Eight additional specimens are referable to this genus and no two of them are alike. The variation is undoubtedly due, at least in part, to the surface irregularity of their hosts. All of the specimens are detached from their hosts and are conical dorsal valves, consequently the true nature of the host is unknown. Faint markings on some suggest that the host was probably a costellate brachiopod. Five of the specimens are flatly conical with the apex slightly eccentric, and the valves nearly circular. One specimen is concave across its middle; another is narrowly elliptical in outline and forms a high cone. The eighth specimen is a small round cone. The largest specimen (USNM 200819) has a diameter of 20 mm. It and the other three flattish forms may be referable to *Petrocrania famelica* (Hall and Whitfield). The others may be aberrations of this species but the specimens are too poorly preserved to be sure.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, i; 521c, m, q; 522j.

Types.—Figured Specimens: USNM 200819, 200954.

Class **ARTICULATA** Huxley, 1869

Order **ORTHIDA** Schuchert and Cooper, 1932

Suborder **ORTHIDINA** Schuchert and Cooper, 1932

Superfamily **ORTHACEA** Woodward, 1852

Family **SKENIDIIDAE** Kozłowski, 1929

Genus **SKENIDIUM** Hall, 1860a

Skenidium independence Stainbrook

Skenidium independence Stainbrook 1945, p. 14, pl. 1, figs. 14–18.

A single dorsal valve of this rare and tiny species was taken at locality 506c. This occurrence helps to reinforce the relationship between the Independence Shale of Iowa and the Sly Gap Formation of New Mexico.

Locality.—506c.

Types.—Mentioned Specimen: USNM 252628.

Order ENTELETIDA Waagen, 1884

Superfamily ENTELETACEA Waagen, 1884

Family ENTELETIDAE Waagen, 1884

Subfamily SCHIZOPHORIINAE Schuchert, 1929

Genus SCHIZOPHORIA W. King, 1850

Schizophoria amanaensis Stainbrook

Plate 4, figures 28–33; plate 39, figures 30–34

Schizophoria amanaensis Stainbrook, 1945, p. 17, pl. 1, figs. 1–13; 1948, p. 770, pl. 1, figs. 5, 6.

Specimens that are nearly as wide as long are referred to this species although they do not conform precisely to Stainbrook's description. Sixteen measured specimens have a mean L/W ratio of 0.88. Five of the specimens have a L/W ratio of over 0.90, indicating specimens nearly as wide as long. These gross measurements are in accordance with Stainbrook's original description and illustrations. All the complete specimens he illustrated (1945, pl. 1, figs. 1–4, 9, 10, 12, 13), and the smaller ventral interior (1945, pl. 1, fig. 11) have the length and width nearly equal. They are rotund specimens resembling *Schizophoria macfarlani* but they definitely are not comparable to Meek's type specimen (USNM 5901a).

Stainbrook mentions a sulcus on the dorsal valve as one of the characters of *S. amanaensis*; this feature is most unusual in *Schizophoria*. Three complete specimens of this species from the Independence Shale in the USNM collections show no trace of a sulcus, nor do any of his figures, except figure 9, which appears to be an aberrant or obese specimen having its length slightly greater than its width. None of the Sly Gap specimens referred here have any trace of a dorsal sulcus. It is likely that this is a character of old age or one of sporadic occurrence. The folding of *S. amanaensis* is like that of *S. iowensis* (Hall, 1858), a sulcus on the ventral valve deep in the front half and a dorsal valve with the fold scarcely elevated except at the very anterior and shown mostly as a deep re-entrant in the anterior commissure of the dorsal valve.

Measurements (in mm).—

	length (L)	dorsal valve length	mid- width (W)	hinge width	thick- ness	L/W ratio
USNM 200880 (loc. 521d)	23.2	23.2	28.3	18.6?	17.6	0.82
USNM 201196a (loc. 523m)	25.3	25.3	29.2	17.5	20.0	0.87
USNM 201195a (loc. 521e)	20.0	20.1	23.3	—	13.7	0.86
USNM 201197a (loc. 526a)	21.4	21.4	23.2	13.0	18.5	0.92
USNM 201198a (loc. 509r)	22.0	22.0	25.1	12.7	17.0	0.88
USNM 201199a (loc. 509n)	23.0	23.0	25.5	15.0	16.6	0.90
USNM 201201 (loc. 509i)	24.0	24.0	28.0	13.0	—	0.86
USNM 201202a (loc. 509i)	23.8	23.8	27.3	18.2	17.8	0.87
USNM 201200a (loc. 362a)	19.0	19.0	22.0	12.0	14.9	0.86

Mean L/W = 0.87.

Stratigraphic occurrence.—Independence Formation; Sly Gap Formation.

Localities.—362a, b; 506c, i; 509p, x, z; 521d; 523 m; 524n, s; 526a, k; 528w, y; 529y; 3045c, i.

Types.—Figured Hypotypes: USNM 200880, 201197a.

Discussion.—Stainbrook compared *S. amanaensis* only to other Iowa species of *Schizophoria*, overlooking the close similarity of his species to *S. macfarlani* (Meek, 1868). The type specimen of this species is in the U.S. National Museum of Natural History (USNM 5901a). Its measurements in mm are: length 21.7, dorsal valve length 21.5, midwidth 22.2, hinge width 14.0, thickness 18.7, length/midwidth ratio = 0.98, midwidth/length ratio = 1.02. The specimen is thus a very thick and rotund one, externally like *S. amanaensis*. The Canadian species, however, seems to be more finely costellate than the Iowa and New Mexico forms, has a narrower dorsal umbonal region and more convex flanks bounding the ventral valve sulcus. Comparison of the few specimens from New Mexico called *S. amanaensis* with the holotype of *S. macfarlani* is not a satisfactory one. The National Collection has only a few specimens identified as *S. macfarlani*. Some of these do not conform to the type and are from several different formations. So few specimens of *S. amanaensis* are now known, and so few are likely to be found in the future, because of the sporadic (cave deposit) nature of the Independence Shale outcrop, that it is unlikely that a satisfactory comparison between the two species can be established.

It is also possible that *S. amanaensis* has an unexpected relationship to *S. iowensis* Hall (1858). Stainbrook (1945, p. 18) mentions the occurrence of another species of *Schizophoria* in the Independence Shale that is thinner, broader and less quadrate than *S. amanaensis*. Indeed his figure 6 is of the ventral valve of a specimen answering this description. The National Collection includes a few specimens of these wide forms that approach *S. iowensis* (Hall) very closely. Unfortunately, enough specimens are not at hand, and those that are have been crushed, to show that these belong to *S. iowensis*.

Specimens like *S. amanaensis* of the Independence Shale occur in the "Hay River Formation on Hay River about mile 26 in Northwest Territories, Canada."*

Schizophoria australis Kindle

Schizophoria striatula Girty, 1900, p. 39.

Schizophoria striatula var. *australis* Kindle, 1909, p. 21, pl. 1, figs. 4–8; pl. 2, figs. 1–5a; pl. 3, fig. 1.

Schizophoria australis Kindle, Stainbrook, 1947, p. 303, pl. 45, figs. 1, 2, 7, 8.

This is one of the largest species of *Schizophoria* found in the United States and one of the largest known anywhere. It is thus very easily recognized in any Percha Formation (Box Member) locality. The specimens figured by Stainbrook do not indicate the full size of the species. Two of the largest specimens measure (in mm): USNM 200890 (loc. 506q): length 44.1, dorsal valve length 43.2, hinge width 28.6, midwidth 58.2, thickness 28.7; USNM 200910 (loc. 507m): length 44.4, dorsal valve length 45.7, hinge width 26.3, maximum width 51.8, thickness 32.3.

Localities.—506, b, p, q; 507a, c, e, g, h, m, n, o, t, w, z; 509a, b, c; 527a, b, c, d, e, f, l, p; 3026; 3026a; 3029; 3031a; 3034 (=507h); 3035. USGS (Kirk) 461; 508; 512.

Types.—Lectotype: USNM 62005e. Paratypes figured by Kindle (1909); USNM 62005a–d. Hypotypes figured by Stainbrook (1947): USNM 135229 (=M.A.S. 1600). Measured Hypotypes: USNM 200890, 200910.

Discussion.—A type was never selected for this species from Kindle's syntypes. The specimen figured by Kindle (1909, pl. 1, fig. 8; pl. 2, figs. 5, 5a—USNM 62005e) is here chosen as lectotype.

Schizophoria lata Stainbrook

Plate 3, figures 6–16; plate 38, figures 25–29

Schizophoria lata Stainbrook, 1940, p. 488, pl. 2, figs. 1–7, 15, 16.

Locality information from label that accompanied specimens.

Medium to large for the genus, wider than long but somewhat variable; sides rounded; subrectangular to broadly elliptical in outline; cardinal extremities obtuse; anterolateral extremities rounded; valves unequally deep, ventral valve shallower; anterior commissure narrowly uniplicate. Beak narrowly pointed; interarea slightly curved, strongly apsacline. Hinge equal in width to about two-thirds maximum width and approximately equal to thickness. Surface costellate, two to four costellae in one mm depending on size of shell.

Pedicle valve flatly convex in lateral profile, varying from nearly flat to slightly concave or slightly convex in anterior profile; umbonal region gently inflated; umbolateral slopes moderately steep; sulcus originating slightly posterior of midvalve, deepening rapidly anteriorly to occupy about half valve width. Flanks bounding sulcus, flat or nearly so. Tongue long, subacute to acute.

Dorsal valve strongly convex, nearly hemispherical in lateral profile; anterior profile a strongly rounded dome with steeply sloping sides. Umbonal and median regions strongly inflated. Fold visible only as deep, narrowly rounded to angular re-entrant in anterior commissure. Flanks swollen.

Ventral valve with muscle field extending about one-third valve length, and about same part of valve width, strongly bilobed; diductors separated by thick median ridge. Vascula media strong.

Dorsal valve interior moderately thickened; adductor field large; brachiophore supports strong and long.

Measurements (in mm).—

	length (L)	dorsal valve length	width (W)	hinge width	thick- ness	L/W ratio
USNM 201204a (loc. 506d)	25.8	25.8	34.0	18.2	14.2	0.79
USNM 201204b (loc. 506d)	25.6	25.0	31.9	19.0	17.9	0.80
USNM 201203 (loc. 509f)	25.8	26.4	31.9	18.3	17.0	0.81
USNM 201206a (loc. 522c)	26.2	26.2	32.8	19.0	17.3	0.80
USNM 200924 (loc. 522h)	26.1	26.1	32.0	19.5	18.7	0.78
USNM 201211 (loc. 523a)	30.2	30.2	34.1	20.0	19.2?	0.89
USNM 200853 (loc. 523d)	24.6	24.4	30.7	16.6	16.0	0.80
USNM 201209a (loc. 523d)	25.2	25.2	30.5	15.4	17.0	0.83
USNM 201209b (loc. 523d)	25.2	25.2	28.6	17.8	18.0	0.88
USNM 201209c (loc. 523d)	26.4	26.4	33.7	17.8	15.0?	0.78

	length (L)	dorsal valve length	width (W)	hinge width	thick- ness	L/W ratio
USNM 201209d (loc. 523d)	25.6	25.0	28.7	15.0	15.7	0.76
USNM 201209e (loc. 523d)	15.7	15.7	20.6	11.0	9.2	0.76
USNM 200956 (loc. 523e)	32.3	32.3	41.7	22.6	26.0	0.76
USNM 201210 (loc. 523e)	27.9	27.9	38.0	18.8	18.7	0.73
USNM 201205a (loc. 523i)	26.0	26.0	30.0	12.7?	16.9	0.86
USNM 201208a (loc. 526c)	27.3	27.3	32.0	15.0	19.6	0.85
USNM 201208b (loc. 526c)	25.7	25.4	31.5	13.8	16.9	0.82
USNM 201207 (loc. 526j)	25.5	25.5	32.3	—	17.8	0.79

Diagnosis.—Medium to large *Schizophoria* having a strongly sulcate ventral valve, little or no fold, and mean L/W = 0.81.

Stratigraphic occurrence.—Oñate Formation.

Localities.—506d; 509f; 522c, f, g, h, j; 523a, b, d, e, f, h, i, k, s, t, u, x, y, z; 524j, q, x; 526c, j; 3023.

Types.—Figured Hypotypes: USNM 200853, 200924, 200956.

Discussion.—The large size, fairly thin shell, and transverse outline distinguish this species readily from *Schizophoria amanaensis* Stainbrook (1945), in which the length and width are nearly equal. It is distinguished from *S. magna* Fenton and Fenton (1924), which has a similar L/W ratio, by its generally larger size, less emarginate anterior margin, and somewhat broader and less angulated sulcus. *Schizophoria lata* is unlike other species of the genus from the Cedar Valley Formation, as it is larger than *S. iowensis* (Hall, 1858) and *S. meeki* Fenton and Fenton (1928) and more transverse than the latter and *S. laudoni* Stainbrook (1940), another large species. It is also unlike any of the species described from Michigan by Imbrie (1959) all of which are from older strata, except *S. mesacarina* Imbrie (1959).

***Schizophoria iowensis* (Hall)**

Plate 3, figures 1–5

Orthis iowensis Hall, 1858, p. 488, pl. 2, fig. 4.

Orthis (*Schizophoria*) *impressa* Calvin (not Hall), 1897, p. 167.

Orthis (*Schizophoria*) *iowensis* (Hall) Hall and Clarke, 1892, pl. 6A, fig. 29.

This species is abundant in the Cerro Gordo Member of the Hackberry Formation at Rockford, Iowa. The size is variable and it has a mean L/W ratio of 0.82 (W/L ratio = 1.21) with the range of the former

from 0.74 to 0.89, indicating a moderately to roundly transverse outline. Although *Schizophoria* is not common in the Sly Gap Formation, a number of localities yielded specimens, here referred to that genus, that are well within the range of variation of *Schizophoria iowensis*. In addition to the agreement in dimensions, these specimens also agree in the character of the fold and sulcus, many having the deeply indented anterior seen in Iowa specimens.

Diagnosis.—Medium sized, transverse *Schizophoria*, with L/W ratio ranging from 0.74 to 0.89, and marked by a deep sulcus in the anterior half of the ventral valve, but without a fold, the tongue of the ventral valve fitting into a deep re-entrant in commissure of the dorsal valve.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, j; 509g, n, s, y; 521c, d, k, m, q, s, w; 524m, n.

Types.—Figured Hypotype: USNM 200955.

***Schizophoria* species 1**

Plate 4, figures 1–6

Medium sized for the genus, wider than long, roundly subrectangular, cardinal extremities and sides strongly rounded. Maximum width posterior to midvalve. Anterior commissure broadly uniplicate. Interarea long and steeply apsacline, only slightly curved. Twelve costellae in five mm.

Ventral valve resupinate in lateral profile and broadly concave in anterior profile. Beak small and narrow, umbonal region nearly flat; umbolateral slopes convex and steeply inclined to the cardinal extremities. Sulcus originating slightly posterior of midvalve, broad and moderately deep, involving more than half anterior; lateral slopes flattened and sloping toward sulcus rather than toward margin as is usual in *Schizophoria*.

Dorsal valve strongly convex in lateral profile and strongly domed in anterior profile, sides dipping strongly to margins. No fold visible except as a deep re-entrant in anterior commissure. Lateral slopes flattened; umbonal and median regions strongly swollen.

Measurements (in mm).—Length 29.5, dorsal valve length 29.5, maximum width 34.2, hinge width 20.0, thickness 19.0, L/W ratio = 0.86.

Diagnosis.—Medium sized *Schizophoria* having a broadly concave ventral valve.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—506d.

Types.—Figured Specimen: USNM 200908.

Discussion.—Only a single specimen of this species was obtained. It is exceptionally well preserved but it occurs with abundant *S. lata* Stainbrook (1940) and may be an aberration of that species. Without more

knowledge of the variation of *S. lata*, the specimen is not named although its characters are unusual and distinctive.

Schizophoria species 2
Plate 4, figures 22–27

One unusually well-preserved specimen has the form and dimensions of *S. amanaensis* Stainbrook (1945) but with much stronger costellae, especially in the sulcus. The fold is somewhat better defined than that of *S. amanaensis* and the sulcus is shallower. The hinge is also narrower than that of *S. amanaensis*.

Measurements (in mm).—USNM 200852: length 22.3, dorsal valve length 22.5, midwidth 25.5, hinge width 15.0, thickness 16.4, L/W ratio = 0.86.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—509p.

Types.—Figured Specimen: USNM 200852.

Schizophoria species indeterminate

Several fragmentary specimens of a small *Schizophoria* were found in the Contadero Formation at localities 523n; 524c; and 526f, g. They are not specifically identifiable.

Superfamily **RHIPIDOMELLACEA** Alichova, 1960

Family **ONNIELLIDAE** Öpik, 1933

Genus **AULACELLA** Schuchert and Cooper, 1931

Aulacella elliptica new species
Plate 2, figures 11–20, 31–59, 73–77;
plate 39, figure 22

About medium size, roundly elliptical in outline; sides strongly rounded; anterior margin broadly rounded; maximum width at midvalve in majority of specimens; posterior with beak of ventral valve slightly protuberant. Hinge narrow, about half valve width. Valves of nearly equal convexity. Anterior commissure slightly curved in ventral direction. Surface multicostellate with fine, narrowly-rounded costellae, implanted and intercalated in four or five generations; twelve costellae in five mm at anterior margin of large specimen.

Ventral valve having gently and evenly convex lateral profile; anterior profile gently and broadly convex, similar to that of lateral profile. Umbonal region narrowly convex and extending anteriorly as low, narrow fold most prominent at midvalve, less so anteriorly; flanks gently convex, separated from the fold by shallow depression on each side of fold. Interarea short, curved and apsacline.

Dorsal valve having about same convexity in lateral profile as that of ventral valve; anterior profile broadly convex, slightly more so than that of ventral valve and marked medially by slight narrow depression representing the sulcus. Umbonal region slightly swollen; posterolateral extremities depressed. Sulcus originating at beak, expanding anteriorly, deepening to about midvalve, then becoming shallower. Flanks gently swollen.

Interior not seen.

Measurements (in mm).—

	dorsal length (L)	valve length (W)	maxi- mum width (W)	hinge width	thick- ness	L/W ratio
USNM 200885 (Holotype; loc. 521e)	12.3	11.7	15.1	7.4	5.6	0.82
USNM 200884 (loc. 526e)	11.5	11.4	13.8	6.0	5.0	0.83
USNM 200888 (loc. 509n)	9.6	9.3	11.9	5.8	4.2	0.80
USNM 200887 (loc. 521d)	8.8	8.7	10.2	5.8	4.9	0.86
USNM 201192a (loc. 524m)	10.8	10.6	12.5	6.6	5.3	0.87
USNM 203562 (loc. 527r)	8.8	8.7	9.8	4.6	4.3	0.90
USNM 201192b (loc. 524m)	9.1	8.6	11.6	6.5	5.0	0.79
USNM 201193 (loc. 524o)	10.1	9.9	12.4	6.0?	4.6	0.81
USNM 201194 (loc. 506j)	9.5	10.6	9.7	6.0	4.7	0.93

Diagnosis.—Roundly elliptical, finely costellate *Aulacella* having compressed valves and tendency for fold and sulcus to merge anteriorly with overall valve convexity.

Stratigraphic occurrence.—Sly Gap Formation; Contadero Formation.

Localities.—Sly Gap Formation: 506c, j, y; 509j, n, p, q, r, s, u, x, y; 521c, d, e, k, m, q, s, t; 523oa; 524m, x; 526a, e, k, r; 527r; 528y; 3016 (=506j).

USGS (Kirk) 543. Contadero Formation: 524o.

Types.—Holotype: USNM 200885; Figured Paratypes: USNM 200884, 200887, 200888, 200909, 203562.

Discussion.—Stainbrook (1948, p. 770, pl. 1, figs. 15, 16) refers specimens from Alamo Canyon to *A. infera* (Calvin, 1878). The specimens figured are juveniles, enlarged $\times 5$, that might be any juvenile punctate orthid. The specimens from the Sly Gap in the National Collection are unlike Calvin's species (see Pl. 2, figs. 21–30). *Aulacella infera* is a squarer form with L/W ratio of 0.90, is much thicker and the costellae are more distant and less numerous. No specimens identifiable with Calvin's species were taken from New

Mexico in all of the collecting for the U.S. National Museum of Natural History.

***Aulacella manticula* (Stainbrook)**

Rhipidomella manticula Stainbrook, 1947, p. 303, pl. 45, figs. 3, 5, 6 (not fig. 4 = *Thiemella platys* n. sp.).

The narrowed hinge region, stout thick valves and anteriorly located maximum width of this species indicate assignment to *Aulacella* Schuchert and Cooper (1931) rather than to *Rhipidomella* Oehlert (1890). The specimens illustrated by Stainbrook in figures 3, 5 and 6 are similar and exhibit the characters mentioned above. The specimen illustrated by figure 4 is differently shaped, and has a somewhat shouldered appearance rather than the sloping posterior margins of the other specimens. This individual (fig. 4) is identical to specimens coming from the Percha Formation (Box Member) farther west in New Mexico and here described under the name of *Thiemella platys*, new species. We suggest that Stainbrook's specimen originated at Hillsboro, New Mexico, at the type locality of the Box Member. It has bits of pink shale adhering to it, as is common with specimens coming from the type locality of the Percha, but this is not seen in any specimens from Rhodes Canyon.

Stratigraphic occurrence.—Rhodes Canyon Formation.

Locality.—East end of Rhodes Pass, San Andres Mountains, New Mexico.

Types.—Holotype: M.A.S. 1589A (=USNM 135260). Figured Paratype: M.A.S. 1589B (=USNM 135261a) (not M.A.S. 1589C = *Thiemella platys* n. sp.).

STAINBROOKIA new genus

Small, strongly biconvex, subquadrate in outline with rounded sides and truncated anterior margin; ventral valve with median fold in young specimens reverting to sulcus at the anterior in old ones; dorsal valve initially with shallow sulcus but changing to an anterior fold in adult or large specimens; anterior commissure uniplicate or sulcate depending on size and age. Ventral valve interarea short and curved; delthyrium open. Surface multicostellate, costellae increasing by implantation in at least three generations.

Ventral valve interior with long diductor scars forming bilobed patch with muscle scars separated by low ridge; pallial trunks diverging anterolaterally from anterior ends of the diductors. Teeth thick and having deep fossettes on their anterior surface.

Dorsal valve interior with thickened cardinalia in adult; brachioophores flattish blades placed obliquely and supported by strong thickenings of adventitious

shell; brachioophores bearing knoblike teeth to articulate with dental fossettes; crura (?) short and blunt. Adductor field subcircular, muscle scars deeply impressed; median ridge variable, usually not strongly developed. Cardinal process with short shaft and trilobed myophore.

Type species.—*Orthis infera* Calvin (1878, p. 728).

Diagnosis.—Small, strongly biconvex Onniellidae having a bilobed ventral muscle field; short-shafted cardinal process; ventral fold and dorsal sulcus reverting to ventral sulcus and dorsal fold in adult stages.

Comparison.—The species described herein were referred previously to *Aulacella* Schuchert and Cooper (1931) which has an interior similar to that of *Stainbrookia* but an entirely different exterior. *Aulacella* is biconvex but its valves are flatly convex and the fold of the ventral valve, although often not strongly developed, is narrow and extends to the anterior margin. The exterior of *Aulacella* is more like that of *Rhipidomella* Oehlert (1890), while the interior of *Stainbrookia* is suggestive of a small species of *Isorthis* Kozłowski (1929).

***Stainbrookia infera* (Calvin)**

Plate 2, figures 21–30; plate 39, figures 18–21

Orthis infera Calvin, 1878, p. 728.

Aulacella infera (Calvin) Stainbrook, 1945, p. 15, pl. 1, figs. 19–28.

Figures of this strongly biconvex species are introduced for comparison with *Aulacella* from the Sly Gap Formation in New Mexico.

Stratigraphic occurrence.—Independence Formation.

Locality.—526w.

Types.—Figured Hypotypes: USNM 200886, 200886b–e.

***Stainbrookia rotunda* new species**

Plate 39, figures 1–7

Small, strongly biconvex shell with ventral valve slightly deeper than dorsal one; subquadrate in outline; wider than long; greatest width at midvalve; sides narrowly rounded; anterior commissure narrowly sulcate. Beak low, strongly incurved and protruding only slightly posterior to hinge, which is narrower than midvalve. Surface multicostellate, costellae strong, increasing in two generations and somewhat fasciculate at the anterior.

Ventral valve strongly convex in lateral profile; anterior profile broadly convex with suggestion of keeled middle. Sides convex and steeply sloping. Fold low, formed by two prominent median costellae; interarea short and strongly curved.

Dorsal valve strongly convex but less so than ventral valve; anterior profile strongly domed and indented medially by narrow and deep sulcus; flanks narrowly convex and steep-sided.

Interior unknown.

Measurements (in mm).—Holotype: length 5.6, dorsal valve length 5.5, hinge width 5.8, midwidth 7.3, thickness 4.9.

Diagnosis.—Small, strongly convex *Stainbrookia* having a deep and narrow sulcus.

Stratigraphic occurrence.—Contadero Formation.

Locality.—524s; 526a.

Types.—Holotype: USNM 207700a; Figured Paratype: 207700b; Unfigured Paratypes: USNM 207700c–g.

Comparison.—This rare species is separated readily from *S. infera* (Calvin) by its small size, strongly convex valves and the deep dorsal sulcus.

Genus **CARINIFERELLA** Schuchert and Cooper, 1931

***Cariniferella alleni* new species**

Plate 1, figures 27–47; plate 3, figures 17–25

Medium size for genus, slightly wider than long, roundly subquadrate in outline, cardinal and anterolateral extremities fairly broadly rounded. Hinge straight, about three-fourths valve width; greatest width at midvalve. Anterior margin with narrow re-entrant medially; anterior commissure sulcate. Surface fascicostellate; costellae narrowly rounded, increasing by bifurcation and implantation, appearing in three generations. At anterior margin of large specimen, one costella separating two or three finer ones from next larger one. Seven or eight costellae in five mm on dorsal valve and seven to ten in same distance on ventral valve, fasciculation of two or three costellae taking place at anterior margin.

Ventral valve evenly and gently convex in lateral profile; broadly convex in anterior profile and narrowly elevated medially. Beak small, narrow, incurved; umbonal region carinate; interarea short, concave and apsacline. Fold low and narrow, formed by a fascicle of costellae somewhat smaller than the largest costellae and thus conspicuous because of this difference. Flanks bounding fold, slightly concave adjacent to fold but faintly convex to flat beyond fold.

Dorsal valve deeper and more convex than ventral valve, moderately convex in lateral profile; anterior profile strongly convex but with median region narrowly depressed by sulcus. Flanks slightly convex and steep in profile. Sulcus originating at beak, narrow and deep but widening anteriorly to occupy about one-third valve width. Costellae of sulcus crowded and of smaller size than those of flanks.

Ventral valve interior with elongate, narrow teeth; dental plates short, obsolescent because of filling of lateral cavities by adventitious shell material; muscle scar cordate, not reaching midvalve; diductor scars narrow, enclosing small adductor scars. Median part of muscle area narrowly elevated and rising to crest at anterior of scar and overhanging a pit anterior to crest which is origin of trough that extends to anterior margin. Genital areas reniform, occupying the posterolateral areas.

Dorsal valve interior greatly thickened, brachio-phores appearing as flat blades supported by adventitious thickening; notothyrial platform thick; cardinal process bilobed, small. Adductor scars on a thickened platform; median ridge, formed by inwardly depressed shell making the sulcus, strong and widening anteriorly.

Measurements (in mm).—

	dorsal length (L)	valve length	mid- width (W)	hinge width	thick- ness	L/W ratio
USNM 200833 (loc. 509i)	19.0	18.7	23.8	14.0	9.7	0.80
USNM 200831 (Holotype; loc. 509p)	17.3	16.5	21.4	14.3	10.0	0.81
USNM 200832 (loc. 521s)	18.5	18.0	21.4	12.0	12.0	0.87
USNM 200837c (loc. 506c)	14.6	14.6	17.8	10.8	9.7	0.82
USNM 200837d (loc. 506c)	12.8	12.2	15.7	10.0	8.7	0.82
USNM 200837e (loc. 506c)	8.9	—	10.7	7.7	—	0.83
USNM 200836 (loc. 521p)	—	18.5	23.5	13.2	—	—

Diagnosis.—Roundly subquadrate *Cariniferella* having narrow fold, deep sulcus and fairly strong bi-convexity.

Stratigraphic occurrence.—Sly Gap Formation (upper part).

Localities.—506c, i, v; 509f, h, i, n, p, r; 521c, e, k, o, p, u; 524m, u, y; 526k; 529s; 3054.

Types.—Holotype: USNM 200831. Figured Paratypes: USNM 200833, 200836, 200837a–d. Unfigured Paratype: USNM 200837e.

Comparison.—Stainbrook identified specimens of *Cariniferella* from the Sacramento Mountains with his species *C. iowensis* from the Independence Shale of Iowa. The two specimens are similar in some details but are sufficiently unlike to be separate species. Although the measurements are similar and the L/W ratio nearly alike for Stainbrook's (1945) figured specimens, the Independence species has a deeper dorsal valve, a narrower and more erect umbo on the dorsal

valve and the flanks of the dorsal valve are steeper. Inside the ventral valve the muscle field is larger than that of *C. allenii*. On the exterior, the ornament of *C. iowensis* is somewhat stronger and the costellae more distant than on *C. allenii*.

Discussion.—*Cariniferella allenii* is a rare fossil. It proves to be more common in the Sacramento Mountains, especially in Indian Wells Canyon, than in the San Andres Mountains or west of that range.

C. allenii n. sp. is named for William T. Allen who, with Arthur L. Bowsher, assisted in our investigations of the Devonian of New Mexico.

***Cariniferella costellata* new species**
Plate 38, figures 13–19

Cariniferella iowensis Stainbrook, 1945, pl. 1, fig. 29 only.

Small for genus, elliptical in outline with well-rounded cardinal and anterolateral extremities. Valves subequally deep. Greatest width at midvalve; anterior commissure narrowly sulcate. Beak small, incurved. Hinge straight, measuring about two-thirds maximum width. Surface costellate, ten in five mm at anterior of holotype, and appearing in three generations.

Ventral valve nearly flat in lateral profile except for umbonal region which is convex; anterior profile subcarinate medially and gently concave on sides; fold beginning at beak, widening anteriorly but narrow throughout and essentially a median fascicle.

Dorsal valve gently convex in lateral profile, broadly convex in anterior profile but narrowly depressed in middle. Sulcus formed at beak, widening and deepening anteriorly and taking about one-third valve width. Flanks bounding sulcus gently convex.

Interior not known.

Measurements (in mm).—Length 11.9, dorsal valve length 11.7, midwidth 16.0, hinge width 11.0, thickness 4.7, L/W = 0.73.

Diagnosis.—Small, transverse *Cariniferella* having fine costellae.

Stratigraphic occurrence.—Independence Formation.

Locality.—526u.

Types.—Holotype: USNM 201214.

Comparison.—A specimen of this species was figured by Stainbrook as *C. iowensis* Stainbrook but compared to the young of that species it proves to have finer costellae, is more transverse, and does not have the narrow swollen umbonal region so characteristic of *C. iowensis*. The species is suggestive of the young of *C. tioga* (Hall, 1867) but that species attains a large size. It is also suggestive of *C. virginia* (H. S. Williams, 1908), but that species is less rounded lat-

erally and has higher shoulders than the Iowa specimens.

***Cariniferella iowensis* Stainbrook**
Plate 2, figures 78–82

Cariniferella iowensis Stainbrook, 1945, p. 16, pl. 1, figs. 29–37.

A single complete specimen has the narrow, rotund form, deep dorsal sulcus, and deep valves of Stainbrook's species and these are the significant characters distinguishing it from *C. allenii* n. sp. of the Sly Gap.

Stratigraphic occurrence.—Sly Gap Formation (bed H).

Locality.—521s.

Types.—Figured Hypotype: USNM 200832.

***Cariniferella* species**
Plate 3, figure 26

Two large ventral valves and a small, complete specimen have many characters, beside size, that separate them from *Cariniferella allenii* n. sp. and *C. iowensis* Stainbrook (1945). These two species have a L/W ratio of about 0.80 and are thus well-rounded shells with length slightly less than the width. The largest specimen of the three mentioned as different is strongly transverse in its adult form and also in the smaller increments that can be seen as growth halts on the shell. The specimen (USNM 200835a) measures (in mm): length 26.6, midwidth 35.5, hinge width 23.0, L/W ratio = 0.75.

This large species suggests *Cariniferella tioga* (Hall, 1867) but differs in having an outline that is more rectangular than broadly elliptical, and in having a smaller muscle area.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—521e.

Types.—Figured Specimen: USNM 200835a.

Family RHIPIDOMELLIDAE Schuchert, 1913

Genus RHIPIDOMELLA Oehlert, 1890

***Rhipidomella* species 1**
Plate 1, figures 10–21

About medium size for the genus, nearly circular in outline; sides and anterior margins strongly rounded; posterior margin somewhat narrowly rounded. Anterior commissure rectimarginate. Beak small, about even with dorsal umbo or slightly anterior thereto. Hinge width at least one-third of maximum width, which is at about mid-valve. Surface finely costellate, costellae separated by spaces of width equal to that of costellae and numbering three in one mm.

Ventral valve gently convex in posterior third but moderately concave anteriorly; anterior profile very broadly concave. Beak small and narrow; interarea short, gently concave and strongly apsacline. Cardinal extremities depressed.

Dorsal valve moderately convex in lateral profile and broadly domed in anterior profile, the side sloping fairly strongly; umbonal and median regions strongly swollen; flanks flattened and steep.

Measurements (in mm).—

	length (L)	dorsal valve length	maxi- mum width (W)	hinge width	thick- ness	L/W ratio
USNM 204950a (loc. 528v)	23.6	23.7	8.6	24.4	8.3	0.97
USNM 204950b (loc. 528v)	22.3	24.1	9.2	24.6	7.8	0.91
USNM 204950c (loc. 528v)	22.3	23.0	10.0	25.0	9.8	0.89
USNM 204950d (loc. 528v)	25.0	24.6	10.0	26.2	—	0.95
USNM 204950e (loc. 528v)	21.1	22.3	9.0	23.2	7.0	0.91
USNM 204950f (loc. 528v)	23.0	23.0	9.7	25.2	7.4	0.91
USNM 204950g (loc. 528v)	21.5	21.0	9.0	22.0	5.9	0.98
USNM 204950h (loc. 528v)	20.0	19.5	9.0	21.2	8.5	0.94
USNM 204950i (loc. 528v)	24.1	23.2	—	24.4	—	0.98
USNM 204950j (loc. 528v)	19.1	18.7	7.5	20.4	—	0.94
USNM 201213 (loc. 528v)	24.1	23.6	8.0	25.1	8.7	0.96

Diagnosis.—Nearly circular *Rhipidomella* having the hinge width less than half the maximum shell width.

Stratigraphic occurrence.—Sly Gap Formation (lower part).

Localities.—506j; 509s; 528v.

Types.—Figured Specimens: USNM 204950a, b; 201213.

Discussion.—*Rhipidomella* is a rare genus in the Upper Devonian rocks of New Mexico. It was found at three localities but was not taken in sufficient quantity to differentiate it satisfactorily from such Middle Devonian species as *Rhipidomella vanuxemi* (Hall, 1857). It seems to be somewhat more convex dorsally than the Middle Devonian species but other details are quite similar. *Rhipidomella* is not only rare in New Mexico, it is also unusual in the Upper Devonian of New York where it has been called either *Rhipidomella leucosia* (Hall, 1860a) or *R. vanuxemi*. The former is a Middle Devonian species but is less common

than *R. vanuxemi*. *Rhipidomella* has not yet been found in the Independence Shale nor has it been taken from the probably related Hackberry Formation (Cerro Gordo Member) in Iowa.

Rhipidomella species 2

A poorly preserved and fragmentary specimen of *Rhipidomella* was collected from the Oñate Formation at locality 529w. It is longitudinally and roundly elliptical as it tapers somewhat anteriorly and posteriorly.

Types.—Mentioned Specimen USNM 207701.

Genus **THIEMELLA** H. S. Williams, 1908

Thiemella platys new species

Plate 2, figures 1–10

Rhipidomella manticula Stainbrook, 1947, p. 303, fig. 4.

Small for the genus, inequivalved, ventral valve having greater depth; transversely elliptical in outline; sides rounded; anterior margin gently rounded; hinge narrow, measuring slightly more than half maximum width, which is at midvalve. Beak small, only slightly protuberant; interarea short and curved, apsacline. Anterior commissure rectimarginate or nearly so.

Ventral valve with faint narrow fold in posterior half, becoming obsolete anteriorly; sulcus on posterior half of dorsal valve becoming obsolete anteriorly. Both valves costellate, costellae narrowly rounded, separated by spaces about equal to or slightly wider than width of costellae; about ten costellae in space of five mm at front of a specimen ten mm long.

Interior not known.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	thick- ness
USNM 200889 (Holotype; loc. 527a)	10.0	9.4	5.6?	12.1	3.9
USNM 200849 (Hypotype; loc. 506)	9.6	9.3	6.4	11.4	4.2
USNM 135261 (loc. 506)	10.2	10.0	6.7	12.0	—

Diagnosis.—Small, roundly elliptical, flatly convex *Thiemella*.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, q; 507h; 527a, p.

Types.—Holotype: USNM 200889. Stainbrook's unfigured Paratype: USNM 135261b (Paratype of *Rhipidomella manticula* Stainbrook, 1947). Hypotype: USNM 200849.

Comparison.—This species is much smaller than the type species *T. villanovia* H. S. Williams (1908) and the fold and sulcus are obliterated anteriorly at a much earlier stage of development. See *Thiemella quadrata* n. sp. for comparison with that species.

***Thiemella quadrata* new species**

Plate 2, figures 60–72

About medium size for the genus, quadrate in outline with rounded cardinal extremities, moderately curved sides and slightly curved anterior margin. Hinge narrower than shell width, approximately half maximum width, which is at about midvalve. Interarea short, curved, apsacline. Anterior commissure rectimarginate. Surface multicostellate, costellae narrowly rounded, increasing by bifurcation and implantation, five costellae in two mm at anterior margin.

Ventral valve gently convex in lateral profile, and flatly convex in anterior view. Fold low, extending from beak to anterior margin and marked by costellae somewhat stronger than those on flanks. Fold outlined by shallow lateral impressions that are faintly demarcated from slightly convex flanks.

Dorsal valve very gently convex in anterior and lateral profiles. Sulcus shallow, one-third to one-quarter valve width, becoming shallower anteriorly. Sulcus bounded by two indistinct folds that correspond to troughs bounding fold, flattening of sulcus anteriorly tending to produce a rectimarginate anterior commissure in adult.

Interior unknown.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	thick- ness
USNM 203533a (Holotype)	11.0	10.9	5.0	11.8	3.8
USNM 203533b (Paratype)	12.0	11.7	6.0	13.3	4.8

Diagnosis.—Medium-sized *Thiemella* having nearly square outline, moderately strong fold and sulcus and well-rounded contours.

Stratigraphic occurrence.—Contadero Formation.

Locality.—527q.

Types.—Holotype: USNM 203533a. Figured Paratype: USNM 203533b.

Comparison.—Although the shape of this species is similar to that of *Thiemella villanovia* H. S. Williams (1908) it is a smaller species, squarer in outline and with sulcus extending farther anteriorly before it begins to swell near the anterior margin. It differs from *Thiemella platys* n. sp., in its nearly square outline,

somewhat finer costellation and in the more prominent development of the fold and sulcus.

This is a rare species, only two specimens having been found.

Family **TROPIDOLEPTIDAE** Schuchert, 1896

Genus **TROPIDOLEPTUS** Hall, 1857

***Tropidoleptus platys* new species**

Plate 4, figures 13–21

Of usual size for genus, subquadrate in outline; hinge narrower than midwidth; gently concavo-convex. Sides rounded; cardinal extremities narrowly rounded. Anterior commissure with faint ventrad wave. Surface multicostate, costae low and rounded, well-developed in posterior and median parts but becoming obsolescent at the anterior. Median costa of ventral valve stronger than the others and opposed by a groove deeper than others on the dorsal valve.

Ventral valve gently convex in lateral profile, most convex at midvalve and posterior thereto; anterior profile slightly carinate medially but broadly convex. Umbolateral slopes moderately steep.

Dorsal valve fairly evenly and gently concave in both profiles, deepest in umbonal region.

Interior not seen.

Measurements (in mm).—USNM 201101e (holotype): length 15.0, dorsal valve length 13.9, hinge width 14.0?, width 17.6, thickness 2.8. USNM 201101b (paratype): length 16.7, dorsal valve length ?, hinge width 16.8?, width 21.8, thickness ?.

Diagnosis.—Gently convex, thin-bodied *Tropidoleptus*, with anterior costation becoming obsolescent in the adult, especially on the dorsal valve.

Stratigraphic occurrence.—Oñate Formation.

Localities.—521z; 529g; USGS (Kirk) 540. 3023b.

Types.—Holotype: USNM 201101e. Figured Paratypes: USNM 201100, 201101a–c. Unfigured Paratype: USNM 201101d.

Discussion.—Comparison of this New Mexico species with *Tropidoleptus* from elsewhere is difficult because the common *T. carinatus* (Conrad, 1839) from the Appalachian region and New York is quite variable. This species is abundant in the Kashong Shale of the New York Hamilton Group but the Kashong specimens are much larger and more convex than *T. platys*. Some specimens of *T. carinatus* show a tendency to obsolescence of the anterior costae but this is not a common feature. Specimens referred to *T. carinatus* from the Tully Limestone of New York are smaller, more convex, and more strongly costate than the New Mexico species. Specimens from the Silica Shale at Milan, southern Michigan, are about the same

size as the New Mexico species but are more strongly costate and more concave.

South American and European species of *Tropidoleptus* are more strongly costate than the New Mexico species, and the European *T. rhenanus* (Frech, 1897) is more transverse. Upper Devonian specimens of *T. carinatus* are more strongly ribbed than the New Mexico species. These, like the Hamilton forms, are variable and in need of systematic revision.

In New Mexico, *Tropidoleptus* occurs in swarms, mostly of young specimens and with scattered adults, in the lower five feet of the Oñate Formation on Capitol Peak and in the Mockingbird Gap (=Johnson Park Canyon).

Order **STROPHOMENIDA** Öpik, 1934

Suborder **STROPHOMENIDINA** Öpik, 1934

Superfamily **STROPHEODONTACEA**
Sokolskaya, 1960

Family **STROPHEODONTIDAE** Caster, 1939

Subfamily **STROPHEODONTINAE** Caster, 1939

Genus **STROPHODONTA** Hall, 1850

Strophodonta umbonata new species

Plate 4, figures 7–12; plate 5, figures 9–18

This is a medium-sized *Strophodonta* having a strongly convex and umbonate ventral valve and deeply concave dorsal valve. The hinge is narrower than the midwidth; the ventral interarea is anacline and the dorsal one is hypercline, so strongly are the valves arched. The umbonal region is strongly costellate and the costellae extend directly from the beak for ten mm where there is a break or growth interruption. At this line another generation of costellae is implanted and after that another generation appears. On the opposite valve the costellae in the first growth segment anteriorly become fasciculate as the new generation of costellae appears.

Measurements (in mm).—USNM 201083 (Holotype): length 22.0, dorsal valve length 16.4, hinge width 20.0 (based on half measure), midwidth 24.8 (based on half measure), thickness 6.5, curvature (surface length of ventral valve) 34.0.

Diagnosis.—Strongly umbonate and deeply concave *Strophodonta* having a narrow hinge.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—509j, n, p, s; 521d, e, t; 524m, s.

Types.—Holotype: USNM 201083. Figured Paratypes: USNM 201084a, b.

Discussion.—The shape and strongly umbonate form of this species are suggestive of *Strophodonta boon-*

ensis (Swallow, 1860) from the Snyder Creek Formation of Missouri but the Sly Gap species has finer costellae, differently arranged, and a narrower shell. This and *Strophodonta* sp. 2 are the only specimens of *Strophodonta* taken from the Sly Gap. *Strophodonta* was on its way toward extinction in Sly Gap time.

***Strophodonta* species 1**

Plate 5, figures 1–4

A single specimen of a very thick-shelled *Strophodonta* has a long (in the direction of valve length), nearly orthocline ventral interarea and a moderately convex ventral valve in lateral and anterior profiles. Unfortunately, the exterior is so badly worn that only traces of the costellae appear. These are strong in the umbonal region but anteriorly increase suddenly at about the middle of the valve. The dorsal valve is moderately concave, most so just anterior to the umbo. The margin on the left side has been damaged but that on the right side is gently convex.

Measurements (in mm).—Length 24.0, dorsal valve length 19.6, hinge width 31.0, midwidth 2.0, thickness 10.2.

Diagnosis.—Thick-shelled, moderately concave *Strophodonta* having a long ventral interarea.

Stratigraphic occurrence.—Oñate Formation (beds C to D).

Localities.—523, a, e, t.

Types.—Figured Specimen: USNM 201085.

Discussion.—We know of no other specimen of *Strophodonta* like this one but the specimen is too poor on which to base a species. One other specimen of *Strophodonta*, very poorly preserved, comes from the Oñate Formation at locality 523. It is small, 15 mm long by 17 mm wide, but with all ornament badly worn. It is strongly concavo-convex and is suggestive both of *Strophodonta erratica* (Winchell, 1866) of the Traverse Group of Michigan and of *S. costata* (Owen, 1852) of the Cedar Valley Formation of Iowa.

***Strophodonta* species 2**

Plate 5, figures 5–8

Small for genus, slightly wider than long and with hinge narrower than midwidth. Dorsal valve moderately concave, ventral valve fairly strongly convex in both profiles. Surface badly worn, but costellate, costellae strong and increasing by implantation.

Measurements (in mm).—USNM 201181: length 11.6, dorsal valve length 10.0, hinge width 10.5, midwidth 12.6, surface length 16.0, thickness 3.7.

Diagnosis.—Small coarsely costate *Strophodonta* with narrow hinge.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—526e; 3054b.

Types.—Figured Specimen: USNM 201181.

Discussion.—This specimen suggests *Strophodonta thomasi* Fenton and Fenton, 1924 in size, but it does not attain the great convexity of that species. It is also suggestive of the Middle Devonian *S. erratica* (Winchell, 1866) but it is not so wide-hinged nor is it so strongly costellate. It seems to be an undescribed species, but the single specimen is too poorly preserved to be the basis of a good description.

Genus STROPHONELLOIDES Caster, 1939

Strophonelloides dorsoconvexus new species

Plate 5, figures 40–51

About average size for the genus, thick-shelled, subrectangular in outline, wider than long; hinge forming widest part; cardinal extremities almost a right angle; sides slightly rounded; anterior margin broadly rounded. Interareas long, flat; pseudodeltidium flush with interarea; ventral valve interarea strongly apsacline, the dorsal one strongly anacline. Surface marked by subangular costellae increasing by bifurcation in four generations; number of costellae increasing suddenly at about midvalve where some costellae produce fascicles of three finer ones.

Ventral valve moderately convex in posterior half but reverting to strongly concave in anterior half; cardinal extremities flattened.

Dorsal valve having umbo slightly concave and posterior half flattened; anterior half strongly convex, anterior profile appearing as a broadly rounded dome. Anterior and lateral slopes steep. Cardinal extremities flattened to concave.

Interior not known.

Measurements (in mm).—

	length	dorsal valve length	hinge width	midwidth	thick- ness
USNM 200862 (Holotype; loc. 509n)	24.8	24.6	32.0	32.0	7.0
USNM 203532 (loc. 527t)	20.9	20.3	23.3	26.1	6.4

Diagnosis.—Thick-shelled, wide-hinged *Strophonelloides* with strong dorsal convexity and deep ventral concavity.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—509n, o, p, r; 521d; 524m; 527t.

Types.—Holotype: USNM 200862; Figured Paratypes: USNM 200864, 203532.

Discussion.—This species strongly suggests *Strophonelloides hybridus* (Hall and Whitfield, 1873) but

proves to have numerous differences when compared with specimens of that species. Its ventral concavity and anterior dorsal convexity are much greater than those of *S. hybridus* (Hall and Whitfield, 1873) from the Cerro Gordo Member of the Hackberry Formation. It also has longer interareas, a less concave dorsal umbo, and lacks the narrow depression that extends from the dorsal umbo onto the convex anterior of the dorsal valve of *S. hybridus*.

This is a very rare species because only six specimens were found in all the collecting. All the features of this species relate it to the *S. hybridus* tribe of *Strophonelloides*.

Strophonelloides deeringi Stainbrook

Plate 5, figures 19–23

Strophodonta reversa Calvin, 1878, p. 728.

Strophonelloides deeringi Stainbrook, 1945, p. 19, pl. 2, figs. 25–33; 1948, p. 771, pl. 1, fig. 25 (not fig. 24 = *S. parvulus* n. sp.).

Figures of this rare Independence Shale species are introduced for comparison with Sly Gap species of *Strophonelloides*.

Stratigraphic occurrence.—Independence Formation.

Locality.—527s.

Type.—Figured Hypotype: USNM 200865a.

Strophonelloides parvulus new species

Plate 5, figures 24–39

Strophonelloides deeringi Stainbrook, 1948, p. 771, pl. 1, fig. 24.

Small, thick-shelled; elongate rectangular in outline; hinge narrower than maximum width which is near midvalve; sides gently rounded; anterior margin narrowly rounded to somewhat nasute. Ventral interarea long and strongly apsacline. Profile resupinate. Pseudodeltidium flush with interarea. Valves multicostellate, costellae increasing by implantation in two or three generations; costellae narrowly angular and strong.

Ventral valve moderately swollen in the posterior half, moderately concave at the anterior; cardinal extremities flattened.

Dorsal valve with posterior half gently convex to flattened; anterior half strongly convex. Cardinal extremities flattened.

Ventral valve interior having a shallow visceral cavity and fairly strong anterior ridge; muscle scars occupying much of the interior of the visceral cavity; palintrope buttressed by a stout pillar. Dorsal valve interior having greatly thickened cardinal process, muscle platform and median ridge.

Measurements (in mm).—

	length	dorsal valve length	hinge width	midwidth	thick- ness
USNM 200866 (Holotype; loc. 509g)	16.0	15.1	14.6	15.3	4.8
USNM 200867b (loc. 506c)	13.6	12.6	12.8	14.2	3.4
USNM 200867a (loc. 506c)	13.8	—	14.0	14.5	—
USNM 201212 (loc. 509n)	19.0	18.2	18.9?	21.9	7.3
USNM 201211a (loc. 524n)	15.2	14.8	13.6	15.9	3.4
USNM 201211b (loc. 524m)	15.5	13.8	15.2	18.2	3.2

Diagnosis.—Small, thick-shelled *Strophonelloides* with gently rounded, nearly parallel sides and hinge narrower than midwidth.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, i, j; 509g, i, j, l, n, r, s, z; 521d, e, u; 523m; 524n, u; 528x.

Types.—Holotype: USNM 200866. Figured Paratypes: USNM 200867a, b, 200872.

Discussion.—Like all members of this genus, this species is quite variable but it is characterized by a hinge narrower than the midwidth, obtuse cardinal extremities, slightly expanding sides, and narrowly rounded anterior margin. It differs from *Strophonelloides deeringi* Stainbrook (1945) in the narrow hinge, rectangular outline, expanded sides and generally smaller size of *S. parvulus* n. sp. and not being strongly nasute anteriorly, or in having the strong median fascicle that forms a prominent fold in Stainbrook's species. Stainbrook's (1948) specimen from the Sly Gap of the Sacramento Mountains was not seen because it was not in the collections presented to the U.S. National Museum of Natural History. The figure of this specimen is strongly suggestive in outline and ornament of *S. parvulus* n. sp. The shape of *S. parvulus* is similar to that of young *S. reversa gravis* (Fenton and Fenton, 1924) but that is a thinner-shelled form with finer ornament.

Subfamily LEPTOSTROPHIINAE Caster, 1939

Genus NERVOSTROPHIA Caster, 1939

Nervostrophia extensa new species

Plate 6, figures 7–14; plate 9, figure 1

Nervostrophia sp. Stainbrook, 1945, pl. 2, figs. 13–17.

Of usual size for genus, twice as wide as long, and extended laterally into large ears. Valves concavo-convex and geniculate about 15 mm anterior to beak.

Angle of geniculation about 100°, geniculation in profile rather narrowly rounded with the anterior slope steep but shorter than more gentle posterior slope. Ventral valve initially costellate with costellae few and separated by numerous radial capillae that occupy interspaces on remainder of the valve. Primary costellae very narrowly rounded and discontinuous as normal in genus. Ornament of dorsal valve contrasting strongly to that of ventral valve in having fewer large primary costellae and with surface mainly covered by fine capillae.

Measurements (in mm).—

	length	dorsal valve length	hinge width	surface length	thick- ness
USNM 201088a (Holotype; loc. 526y)	19.7	18.8	39.2*	23.5	2.9
USNM 201088c	15.2	14.6	32.4*	17.5	1.8
USNM 201180a (loc. 362a)	17.0	15.9	38.0	20.0	3.6

Diagnosis.—*Nervostrophia* having the width about twice the length.

Stratigraphic occurrence.—Independence Formation; Sly Gap Formation.

Localities.—Independence Formation: 362a; 526y; Sly Gap: 506c; 521p.

Types.—Holotype: USNM 201088a. Figured Paratypes: USNM 201034, 201093.

Discussion.—In its great width this species is unlike any described species of *Nervostrophia*. Two poorly preserved Sly Gap specimens are referred here on the basis of their shape, size and ornamentation.

Nervostrophia geniculata new species

Plate 6, figures 15–31

About medium size or moderately large for genus, subrectangular in outline and concavo-convex in longitudinal section; sides nearly straight to gently convex; anterior margin broadly rounded; length less than greatest width, which is at about midvalve; hinge wide but not exceeding the midwidth; beak small, slightly protuberant; interarea short, apsacline; pseudodeltidium small. Ornament of valves different, that of ventral valve having strong elevated discontinuous costellae that often swell locally; primary costellae separated by narrow interspaces occupied by one or two radial capillae, except on umbonal region where radial capillae are more numerous. Dorsal valve with primary costellae present but distant and separated by numerous radial capillae (as many as five).

Ventral valve unevenly convex, posterior half gently swollen, geniculation taking place near midvalve, an-

terior slope convex and steep. Anterior profile broadly, but not strongly convex. Lateral slopes moderately steep; cardinal extremities obtuse.

Dorsal valve closely fitting the profile of the ventral valve, the maximum concavity about two-thirds the length from the beak and having steep slopes dipping toward the posterior margin of the concavity.

Interior not seen.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	sur- face length	thick- ness
USNM 200934 (Holotype; loc. 521p)	24.8	23.5	23.6?	29.7	29.5	2.7
USNM 200933a (loc. 506c)	24.7	—	25.7?	32.0	30.0	—
USNM 200932 (loc. 509h)	23.7	—	25.2?	28.8	28.0	—

Diagnosis.—Moderately large *Nervostrophia* geniculated at midvalve and having the length about 80 percent of the midwidth.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c; 509h, i, q; 521d, p, q, w; 524m, n; 526d, r.

Types.—Holotype: USNM 200934. Figured Paratypes: USNM 200932, 200933a, b.

Discussion.—This species differs from *Nervostrophia rockfordensis* (Fenton and Fenton, 1924) and *N. solida* n. sp., in being geniculate at midvalve, being somewhat smaller, and with shorter interareas. It is unlike *N. calvini* Stainbrook (1945) in its longer interarea, more crowded primary costellae, and stronger geniculation.

Nervostrophia mucrospina new species

Plate 7, figures 1–16

Small for genus, wider than long, narrowly subrectangular in outline; strongly concavo-convex in profile; hinge wider than midvalve and drawn laterally into long points of five to seven mm; sides rounded and sloping moderately medially; posterolateral extremities forming small ears and set off by oblique, shallow depression. Anterior margin broadly rounded. Interarea short (in direction of valve length), apsacline to orthocline; pseudodeltidium flush with surface of interarea. Surface of ventral valve costellate, primary costellae narrow, elevated, about five or six in space of five mm at anterior of average specimen; interspaces occupied by about four radial capillae; dorsal valve surface with primary costellae subdued and radial capillae dominating.

Ventral valve unevenly convex in lateral profile, posterior gently convex, median region bent at angle of about 110°, front half gently convex; anterior profile fairly strongly domed with median region somewhat narrowly convex and sides sloping fairly steeply; posterior and umbonal regions moderately swollen; lateral slopes moderately steep. Median anterior half may be subnasute.

Dorsal valve moderately concave, valve fitting closely to contours of ventral valve, most concave a short distance anterior to midvalve; lateral slopes moderately steep; cardinal extremities slightly concave.

Interior of neither valve seen.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness	sur- face length
USNM 201009 (loc. 521m)	17.8	16.6	20.0?	23.3	3.0	22.5
USNM 201178a (loc. 509n)	13.0	12.1	14.6*	17.0?	2.7	16.0
USNM 201039 (loc. 521k)	13.4	12.8	16.0?	16.7	—	—
USNM 201024a (Holotype; loc. 509p)	16.0	—	31.0*	19.0	—	18.0
USNM 201024b (loc. 509p)	16.7	15.6	21.8?	19.0	—	20.0
USNM 201024c (loc. 509p)	8.7	—	18.2	12.8	—	11.0
USNM 201026a (loc. 506j)	12.4	11.4	14.3?	16.0	—	—
USNM 201026b (loc. 506j)	11.5	—	33.8	15.4	—	13.5
USNM 201209 (loc. 521e)	12.3	—	32.8	16.7	—	13.0?

Diagnosis.—Small, concavo-convex *Nervostrophia* with mucronate cardinal extremities.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506j; 509f, h, i, n, p, r, s, z; 521d, e, k, m, q, s, t, u, w; 524n; 526d, s; 3016. USGS (Kirk) 538.

Types.—Holotype: USNM 201024a. Figured Paratypes: USNM 201024b, c; 201026a, b; 201028; 201039.

Discussion.—This species suggests *Nervostrophia canace* (Hall and Whitfield, 1873) from the Cerro Gordo Member of the Hackberry Formation. It differs, however, in being much smaller, more narrowly geniculated, and with finer ornament. It is less wide than *N. extensa* n. sp., from the Independence Shale. It differs from *N. multinervosa* Stainbrook (1945), also from the Independence Shale, in greater curvature, finer ornament, and smaller size.

Nervostrophia multinervosa Stainbrook

Plate 7, figures 22–25

Nervostrophia multinervosa Stainbrook, 1945, p. 32, pl. 2, figs. 5–8; 1948, pl. 1, fig. 4.

Two specimens are referred to this species. Another fairly large transverse specimen (USNM 201087), is free of matrix but is so badly exfoliated and worn that little of the ornament is revealed and it can only tentatively be assigned to *N. multinervosa*. The other two (USNM 201035a, b) are smaller, and reveal only the ventral valve, but have fairly well preserved ornament that consists of fine radial lines separated by capillae. The smaller of these two specimens has the radii more crowded than in the specimen herein referred to *N. cf. N. multinervosa*.

Stratigraphic occurrence.—Sly Gap Formation; Independence Formation.

Localities.—509g; 521d.

Types.—Figured Specimens: USNM 201035a, b.

Discussion.—Stainbrook (1945) figured, but did not describe, a specimen (USNM 135271) from loc. 506c. This is a poorly preserved specimen, lacking the dorsal valve but displaying well the ventral valve ornament. The species also occurs in the Independence Formation at Brandon and Independence, Iowa (Stainbrook, 1945, p. 33).

Nervostrophia cf. N. multinervosa Stainbrook

Plate 7, figures 17–21

A specimen showing both valves but with exfoliated ornament (USNM 201087) measures (in mm): length 19.6, dorsal valve length 18.7, hinge width 23.2, maximum width 28.2, surface length 26.0, thickness 3.8, height 8.7.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—506c.

Type.—Figured Specimen: USNM 201087.

Nervostrophia plana new species

Plate 6, figures 1–6

About medium size for genus, wider than long and subrectangular in outline; hinge wide, commonly extended into acute points, profile slightly concavo- to plano-convex. Sides gently rounded; anterior margin broadly rounded. Interarea short, apsacline. Pseudodeltidium narrow. Ventral valve marked by low, rounded discontinuous primary costellae separated by wide interspaces occupied by as many as six radial capillae. Dorsal valve similarly ornamented but primary costellae more subdued and radial capillae more prominent.

Ventral valve faintly convex in both profiles; umbonal and median regions faintly swollen; posterolateral extremities slightly concave. Mucronate points thin and extending laterally about 5 mm.

Dorsal valve faintly concave in both profiles; posterior third nearly flat but median third gently concave and anterior third flat. Cardinal extremities flattened.

Ventral valve interior having hinge nearly completely dentate; paracardinal plates stout and solid forming an angle of about 57°; muscle area flabellate; adductor marks low but thick; pseudodeltidium buttressed by an apical callosity.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 200841a (Holotype; loc. 523u)	22.3	—	40.0*	27.3	—
USNM 200841b (loc. 523u)	20.0	—	41.2*	26.0*	—
USNM 203531 (loc. 527u)	22.6	22.0	—	29.4	≤1.0

Diagnosis.—Very flat *Nervostrophia* having distant low primary costellae in a matrix of fine radial capillae.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522d, h, n, z; 523a, b, c, d, e, i, s, u, x; 524a, i, k, l, p, q; 526b, c, h; 527u; 528t; 529g, k, m, n; 3023d.

Types.—Holotype: USNM 200841a. Figured Paratypes: USNM 200841b; 200929; 203531.

Discussion.—This species is distinguished immediately from *Nervostrophia rockfordensis* (Fenton and Fenton, 1924) and *N. solida* n. sp., in being flatter than either of them and in having much finer ornament. *Nervostrophia plana* suggests *N. tulliensis* (H. S. Williams, 1890), as it is similarly ornamented, but the Tully species is smaller and more convex. *Nervostrophia nervosa* (Hall, 1843) is also more convex than the Oñate species.

Nervostrophia solida new species

Plate 7, figures 26–35; plate 8, figures 40, 41

Nervostrophia thomasi Stainbrook, 1948, p. 772, pl. 1, fig. 1 (not fig. 2).

Large for genus, and thick-shelled; subrectangular in outline, sides gently rounded; anterior margin broadly rounded; hinge forming widest part of shell in well-preserved specimens; valves of unequal depth, the ventral valve faintly convex, the dorsal valve from slightly convex to gently concave. Ventral interarea moderately long; pseudodeltidium flat but bearing a

narrow median ridge (monticulus); chilidium narrowly rounded, strongly elevated. Surface of ventral valve costellate, costellae of two sizes; largest costellae often discontinuous; costellae separated by wide interspaces marked by fine radial capillae crossed by fine concentric fila. Dorsal valve surface costellate, the larger costellae widely spaced and separated by radial capillae that are cancellated by concentric fila more numerous than on the opposite valve. The dorsal valve thus gives the appearance of a more subdued ornament than that of ventral valve.

Ventral valve faintly convex in both profiles; umbonal region slightly convex; cardinal extremities flattened. Dorsal valve in old specimens somewhat thickened submarginally.

Ventral interior with large flabelliform muscle area like that of *Protoleptostrophia* Caster (1939). Dorsal valve interior with adductors deeply inset in adventitious shell; cardinal process with narrow lobes; brachioophores short and stout, set close to the cardinal process.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 200842 (loc. 509k)	26.4	24.6	33.6*	33.6	4.9
USNM 200843a (loc. 506c)	29.8	27.8	40.4*	38.2*	4.8
USNM 200843c (Holotype)	29.8	28.0	—	34.0*	3.0

Diagnosis.—Coarsely costellate, stout-shelled *Nervostrophia* having radial capillae on most of shell surface in both mature and early stages.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, v; 507; 509g, h, i, j, k, l, r, s; 521c, d, e, l, n, o, s, u, v, x; 522k; 523c; 524m; 526k; 528j; 3025. USGS (Kirk) 538.

Types.—Holotype: USNM 200843c. Figured Paratypes: USNM 200842, 200843a, 200879. Unfigured Paratype: USNM 200843b.

Discussion.—This species is similar to *Nervostrophia thomasi* Stainbrook (1945) and *N. rockfordensis* (Fenton and Fenton, 1924). From the former it differs in having stronger, more distant costellae, and the interspaces between the costellae in midvalve and the anterior are marked by fine radial capillae crossed by fine concentric fila. *Nervostrophia thomasi* is not so strongly costellate and the interspaces have fewer capillae and stronger concentric lines. *Nervostrophia rockfordensis* has strong costellae that are like those of *N. solida* n. sp. but are more crowded and do not

have radial intercostellar capillae, but, like *N. thomasi*, it is provided with strong concentric fila.

This is a very fragile shell because of the thinness of the anterior portions; consequently no complete specimens appear in the collection. Some specimens are fragments, but are typically ornamented. The species is most abundant at locality 506c in the Sacramento Mountains.

Genus PSEUDODOUVILLINA Stainbrook, 1945

Pseudodouvillina euglyphea Stainbrook

Plate 8, figures 1–7

Pseudodouvillina euglyphea Stainbrook, 1945, p. 27, pl. 3, figs. 17–20; 1948, p. 771, pl. 1, figs. 28–30.

This is a small species that is difficult to separate from young *Douvillina* Oehlert (1887) unless the interior characters are clearly visible. Specimens are rectangular, slightly wider than long, with gently rounded sides and narrowly rounded front margin. The hinge is narrower than the midwidth. The lateral profile is strongly but unevenly convex with the maximum convexity in the posterior third; the anterior profile is narrowly convex with precipitous sides and the top often somewhat keeled. The valves are ornamented by primary costellae, moderately crowded and separated by radial capillae.

Internally, the ventral valve is like that of *Nervostrophia* but has prominent divergent parodontal plates and the long slender diductor scars are separated by a prominent median septum. The dorsal valve interior is not supplied with the brace plates so characteristic of *Douvillina*.

A typical specimen (USNM 201055a) measures (in mm): length 7.8, dorsal valve length 6.8, hinge width 8.3, maximum width 8.8, surface length 12.0, thickness 2.2

Diagnosis.—Small, rectangular, strongly concavo-convex shells having an interior like that of *Nervostrophia*.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, i, v; 509g, i, j, k, m, n, w; 521l, o, r; 526f, k; 3045b.

Types.—Figured Hypotypes: USNM 201055a, b.

Discussion.—This species is commonest in the Sacramento Mountains. Although *Pseudodouvillina* was placed in synonymy with *Nervostrophia* Caster (1939) by A. Williams (1965, p. H398), the size, shape, ornamentation and details of the ventral valve interior are sufficiently distinct to warrant the retention of Stainbrook's genus, in our opinion.

Genus **SULCATOSTROPHIA** Caster, 1939**Sulcatostrophia calvini** (Miller)

Plate 8, figures 20–25

Strophodonta quadrata Calvin, 1878, p. 728.*Strophodonta calvini* Miller, 1883, p. 298.*Strophodonta exilis* Calvin, 1883, p. 443.*Sulcatostrophia calvini* (Miller) Stainbrook, 1945, p. 29, pl. 3, figs. 6–11, 23–24; 1948, p. 772, pl. 1, figs. 31, 37.

This is a small species that occurs with specimens of *Douvillina* Oehlert (1887) and *Pseudodouvillina* Stainbrook (1945); it has both shape and ornament similar to those genera. It is readily distinguished, however, by having a broad shallow sulcus on the ventral valve. The interior is like that of *Nervostrophia* Caster (1939). *Sulcatostrophia* has been put into synonymy with the latter genus (Williams, A., 1953, p. 41; 1965, p. H398), but we consider it a valid genus.

Diagnosis.—Small, rectangular shells ornamented as in *Nervostrophia* but having a broad, shallow sulcus on the ventral valve.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, v; 509m, w, y; 521c, d, l; 526k.

Types.—Figured Hypotypes: USNM 201138, 201059a, b.

Discussion.—This is a rare species and all specimens come from exposures in the Sacramento Mountains. In our opinion, the combination of characters listed above serve to set this apart from *Douvillina* and *Pseudodouvillina*, on the one hand, and *Nervostrophia* on the other.

Subfamily **DOUVILLININAE** Caster, 1939Genus **DOUVILLINA** Oehlert, 1887**Douvillina arcuata** (Hall)

Plate 8, figures 14–19

Strophodonta arcuata Hall 1858, p. 492, pl. 3, figs. 1a–c.*Douvillina arcuata* (Hall) Fenton and Fenton, 1924, p. 87 (for synonymy); Williams, A., 1953, pl. 11, figs. 7–9.

In the Hackberry Formation (Cerro Gordo Member) of Iowa, this is an abundant but variable form. Most specimens, in the early growth stages of the shell, have fairly closely crowded costellae with only one or two radial capillae intervening. Anteriorly, the larger costellae are also crowded. One specimen from the Sly Gap conforms to this species.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—506c.

Types.—Figured Hypotype: USNM 201044.

Douvillina contaderoensis new species

Plate 8, figures 26–39; plate 38, figures 20–23

About medium size for genus, wider than long; fairly deeply concavo-convex. Hinge forming widest part when well preserved; cardinal extremities mucronate. Sides slightly oblique; anterior margin broadly rounded. Ornament consisting of six or seven larger costellae in the space of five mm at the front of an average specimen; spaces between costellae occupied by fine radial capillae.

Ventral valve moderately to strongly convex with maximum convexity at midvalve when viewed in lateral profile. Anterior profile forming broad moderately swollen dome with gently descending sides. Anterior slope gently convex and steep; beak small; umbonal region gently convex; interarea short, apsacline.

Dorsal valve closely fitting inside of ventral valve; maximum depth slightly anterior to midvalve; sides sloping fairly steeply toward midvalve. Interarea short, anacline. Ears concave.

Measurements (in mm).—

	dorsal valve length	hinge width	mid- width	sur- face length	height	thick- ness	
USNM 200970 (loc. 521j)	16.6	15.0	22.0	19.9	19.0	5.0	2.7
USNM 200971 (loc. 521j)	16.0	14.1	22.6	21.4	20.0	5.4?	3.1
USNM 200991b (loc. 509t)	16.0	—	22.8	20.3	20.0	4.3	—
USNM 201009 (loc. 523n)	17.4	16.0	—	22.8	22.3	6.4	3.0

Diagnosis.—Fairly large, moderately convex *Douvillina*.

Stratigraphic occurrence.—Contadero Formation.

Localities.—509t; 521j; 522a; 523n; 524s, t; 526a, g; 3054k.

Types.—Figured Hypotypes: USNM 200970; 200971; 200991a, b; 201009.

Discussion.—This species is fairly common in the Contadero Formation and is confined to it. It is distinguished by its relatively large size, for *Douvillina*, but is distinguished by its width and lesser convexity than *D. arcuata* (Hall, 1858) and the other species of the genus described here. It is similar to *D. cayuta* (Hall, 1867) of the New York Chemung Formation but is usually somewhat smaller and more convex than that species.

Douvillina minuta new species

Plate 8, figures 8–13; plate 9, figures 2–9

Small for the genus, subcircular in outline with the length equal to or exceeding the width; sides and anterior rounded; hinge wide but not equal to midwidth, extended into minute ears. Lateral profile strongly but unequally convex, the maximum convexity at about one-third length from beak; anterior slope long and convex; posterior slope short, slightly convex but very steep. Ornament consisting of strong angular primary costellae forming crest of low plications, median costellae most prominent and forming a sort of keel. Interspaces occupied by a few radial capillae. Dorsal valve with low angular plications occupied by a costella and with interspaces marked by radial capillae.

Interior not seen.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	surface length	thick- ness
USNM 201056 (Holotype; loc. 506c)	7.7	6.9	6.5	7.6	11.0	2.0
USNM 201076 (loc. 521n)	7.0	6.4	5.6	6.4	10.0	—
USNM 201075 (loc. 524m)	8.5	6.8	6.1	7.4	12.0	—

Diagnosis.—Very small, rotund, strongly costellate *Douvillina*.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c; 521n; 524m.

Types.—Holotype: USNM 201056. Figured Paratypes: USNM 201075, 201076.

Discussion.—The small size and strong ornamentation distinguish this species from all other described species of *Douvillina*. The species is a rare one.

***Douvillina parviuscula* new species**

Plate 9, figures 14–25

Small for the genus, subquadrate in outline but with width slightly greater than length; hinge narrower, equal to, or slightly wider than width at midvalve; cardinal extremities slightly auriculate; sides nearly straight to gently rounded; anterior margin strongly curved. Interarea short, curved, orthocline to anacline. Pseudodeltidium flat but commonly with median elevation (monticulus). Surface of ventral valve multicostellate and capillate, six primary costellae in five mm at midvalve but two in one mm at the anterior margin, and often raised to form crest of a low plication; primary costellae increasing abundantly beyond midvalve; interspaces on posterior half occupied by as many as nine radial capillae, but fewer than that anteriorly where

costellae are less distantly spaced. Dorsal valve with primary costellae subdued and radial capillae dominant.

Ventral valve strongly convex in lateral profile, the posterior slope shorter and steeper than the anterior slope; geniculated at three to four mm anterior to beak; anterior profile a narrow dome with steeply dipping sides. Beak small, umbonal region gently swollen, swelling continuing anteriorly to form indistinct fold that is lost in strong swelling at midvalve; posterolateral slopes steep and gently concave, producing a small, narrowly rounded ear.

Dorsal valve conforming closely to contour of ventral valve, thus deeply concave in median region with anterior slopes steeply dipping toward posterior; umbonal region flattened; posterolateral region slightly concave at small ears.

Ventral valve interior with thick rim around diductor field. Dorsal valve interior not known.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	sur- face length	thick- ness
USNM 201057a (loc. 521e)	10.6	9.5	9.4*	10.4	15.5	2.4
USNM 201054 (Holotype; loc. 509r)	10.8	9.8	10.8	11.4	14.0	2.0

Diagnosis.—Small, strongly convex, narrow-hinged *Douvillina* having small ears.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, i, j; 509h, j, n, r, s, y, z; 521d, e, m, q, r; 524m, n; 526f, m; 528y; 3025a; 3053; 3054f; USGS (Kirk) 543.

Types.—Holotype: USNM 201054. Figured Paratype: USNM 201057a. Unfigured Paratypes: USNM 201057b–e.

Discussion.—This species is slightly smaller than *Douvillina navicula* Stainbrook (1945) from the Independence Formation of Iowa, but it also differs in lacking the somewhat keeled median region, in having less pronounced ears, and in not having strong mucronate points extending from the ears.

***Douvillina rectangulata* new species**

Plate 9, figures 26–37

Small, length and width nearly equal, deeply concave, ventral valve moderately geniculated just posterior to midvalve, dorsal valve fitting interior of ventral valve closely. Hinge slightly wider than midvalve

and extended onto small ears, not quite forming right angle. Sides subparallel and anterior margin broadly rounded. Ventral interarea short, curved, orthocline to anacline; dorsal interarea short, hypercline. Surface costellate and capillate, costellae numbering about three in two mm and separated by up to six capillae.

Ventral valve strongly convex in lateral profile and narrowly domed in anterior profile; lateral slopes steep; ears narrowly rounded. Umbonal region very slightly protuberant beyond the posterior margin.

Dorsal valve deepest at midvalve with sides and anterior sloping steeply toward midvalve; ears narrowly concave.

Interior of both valves not known.

Measurements (in mm).—

	dorsal valve length	hinge length	mid- width	sur- face length	thick- ness	height
USNM 201031 (Holotype; loc. 521e)	9.9	8.8	10.6*	10.5	14.5	2.4
USNM 201030 (loc. 509n)	10.4	9.0	9.2?	11.0	16.0	2.8

Diagnosis.—Small *Douvillina* having length and width nearly equal, subparallel sides, and moderate geniculation posterior to midvalve.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—509ha, n; 521e.

Types.—Holotype: USNM 201031. Figured Paratype: USNM 201030.

Discussion.—This species is most similar to *Douvillina parviuscula* n. sp., but differs in having a more compact form, more rectangular outline, stronger convexity and, consequently, deeper dorsal valve; it also has a different geniculation and more subdued ornament. This species is rare in the Sly Gap.

Douvillina species 1

Plate 9, figures 45–50

About medium-sized to large for genus, deeply concave dorsally and strongly convex on ventral side. Hinge slightly narrower than midvalve width, where shell is widest. Anterior strongly rounded; sides moderately rounded. Interarea strongly apsacline and moderately long. Valves geniculated at about midvalve, the anterior slope convex and steep, the posterior slope flattened and steeper than anterior one. Surface of umbonal part marked by distant narrow costellae separated by numerous radial capillae; primary costellae increasing and becoming crowded at anterior side of geniculated part of shell and with few

radial capillae intervening. Dorsal valve with costellae often elevated on low plications.

Measurements (in mm).—USNM 201040: length 13.4, dorsal valve length 11.9, hinge width 15.5 (based on half measure), midwidth 17.4, surface measure 18.0, thickness 2.7.

Diagnosis.—Medium to large *Douvillina* with distant primary costellae in posterior half but crowded primary costellae on the anterior slope.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c; 509j, n, s, x; 521d, m.

Types.—Figured Specimen: USNM 201040.

Discussion.—Not one of the localities listed above yielded enough specimens to get a good idea of this species. It is larger than *Douvillina parviuscula* n. sp., although similarly marked. The specimens referred here vary in degree of convexity.

Douvillina species 2

Plate 8, figures 42–54

About medium size for genus, wider than long, subrectangular, hinge width variable, usually less than midwidth; sides gently rounded; anterior more broadly rounded. Geniculation sharp, occurring 3–4 mm anterior to beak. Interarea anacline. Ventral valve strongly but unevenly convex in lateral profile; anterior three-fourths moderately convex, posterior quarter narrowly curved with dorsal slope directed anteriorly. Surface ornamented as in *Douvillina parviuscula* n. sp.

Measurements (in mm).—

	dorsal valve length	hinge width	maxi- mum width	surface length	thick- ness
USNM 203561a (loc. 527v)	7.3	6.0	7.3	9.2	12.0
USNM 203561b (loc. 527v)	9.0	8.5?	10.0	10.6?	17.0
USNM 204951 (loc. 527v)	7.8	6.4	8.0	8.9	12.0

Diagnosis.—Small, strongly geniculated *Douvillina* with short posterior slope inclined ventrally.

Stratigraphic occurrence.—Contadero Formation (coral bed).

Localities.—523r; 524s; 526a, g; 527v.

Types.—Figured Specimens: USNM 203561a, b; 204951.

Discussion.—This species is similar in size and ornament to *Douvillina parviuscula* n. sp. but differs in having the posterior slope so strongly curved that it is actually directed ventrally, so strong is the geniculation.

Genus **DOUVILLINARIA** Stainbrook, 1945**Douvillinaria diversa** new species

Plate 9, figures 51, 52; plate 10, figures 1–14

Fairly large for the genus, squarish in outline; hinge narrower than greatest width which is at or near mid-valve; valves unequal in depth, dorsal valve deeper; sides gently rounded; anterior margin strongly rounded; hinge straight; anterior commissure rectimarginate. Interareas nearly equal in length (direction of valve length); ventral interarea strongly apsacline and dorsal strongly anacline. Pseudodeltidium narrow, flush with interarea but marked medially by narrow elevation or monticulus. Surface multicostellate, costellae fine and rounded at the posterior but thickening anteriorly and capping low plicae; costellae increasing mainly by implantation. Costellae separated by wide interspaces occupied by fine longitudinal threads or capillae.

Pedicle valve usually unevenly convex, flatly convex posteriorly but gently convex anteriorly; anterior profile broadly and slightly convex. Ventral valve slightly concave near midvalve and anterior half gently convex.

Dorsal valve, in lateral profile, gently convex in posterior third but flattened or slightly concave in anterior half to two-thirds. Umbonal region flattened or slightly concave but region anterior to umbo convex, to about one-third the valve length, becoming slightly concave or flat to anterior margin. Anterior profile broadly and gently convex with median part narrowly humped and sides gently sloping to margins.

Ventral valve interior having a short, broadly heart-shaped muscle area with elevated rim. Dorsal valve interior with all structures thickened; brachioophores conspicuous; brace plates thick, expanding anteriorly and making contact posteriorly with the anterior end of the median ridge.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	thick- ness
USNM 200870a (loc. 509h)	13.3	13.1	10.7	14.1	3.4
USNM 200870b	9.1	8.9	9.1	9.7	2.9
USNM 200869a (Holotype; loc. 521c)	14.1	13.9	12.4	16.0	3.7
USNM 201191a (loc. 506c)	12.8	12.8	11.2	14.3	5.0
USNM 201191b	15.0	14.5	14.7	17.7	4.0

Diagnosis.—Fairly large *Douvillinaria* without a strong median fold and sulcus and with the initial stages usually biconvex, convexo-plane or convexo-concave.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, j; 509h, k; 521c, m, s, t, v; 524m, u; 526d.

Types.—Holotype: USNM 200869a. Figured Paratypes: USNM 200868, 200869b, 200870a. Unfigured Paratypes: USNM 200870b, 201191a.

Discussion.—This species attains the size of *D. variabilis* (Calvin, 1878) but has a different lateral profile which is usually convexo-plane in the posterior half but concavo-convex in the anterior half. The dorsal valve in early life is strongly convex but in maturity it flattens or becomes gently concave. It is larger than *D. perversa* Stainbrook (1945) and has a different profile. It is smaller than *D. delicata* (Fenton and Fenton, 1924), which has a concave dorsal valve and does not have the early part of that valve swollen.

Douvillinaria variabilis (Calvin)

Plate 9, figures 38–44

Strophodonta variabilis Calvin, 1878, p. 727; Hall and Clarke, 1892, p. 289, pl. 15B, figs. 4–6.

Douvillinella variabilis (Calvin) Stainbrook, 1935, pl. 83, fig. 9.

Douvillinaria variabilis (Calvin) Stainbrook, 1945, p. 24, pl. 3, figs. 1–4, 25; 1948, p. 771, pl. 1, figs. 26, 27.

Specimens assigned to this species have a fairly conspicuous fold on the ventral valve and a sulcus on the dorsal valve. The specimens are large and compare favorably with material from the Independence Formation of Iowa.

Diagnosis.—Large, moderately concavo-convex *Douvillinaria* with a well-marked fold and sulcus.

Stratigraphic occurrence.—Sly Gap Formation; Independence Formation.

Locality.—506c; 509h, i; 521e, m; 526m.

Types.—Figured Hypotypes: USNM 200871a, b.

Family uncertain

FLOWERIA new genus

Medium to large size, subrectangular in outline with sides gently rounded, anterior margin broadly rounded; valves plano-convex to unequally biconvex, greater convexity on ventral valve. Interareas on both valves, that of dorsal valve greatly reduced, that of ventral valve moderately long (longitudinally). Pseudodeltidium moderately convex and rounded; chilidium reduced, marked medially by a depression or notch. Anterior commissure variable. Surface costellate, costellae appearing in several generations. Shell substance without taleolae (not pseudopunctate).

Ventral valve interior with thick teeth; muscle field subcircular.

Dorsal valve with bilobed cardinal process, each lobe of which is grooved medially; cardinal process welded to brachiophores, which are short rods encased in tissue; forming a cuplike socket. Anterior surface of cardinalia medially marked by small angular node representing depression in chilidium that divides cardinal process lobes. Adductor field roundly flabellate and marked medially by low or indistinct myophore.

Type species.—*Orthis prava* Hall, 1858, p. 490 (= *Schuchertella prava* (Hall) Fenton and Fenton, 1924, p. 117, pl. 20, figs. 21–28).

Diagnosis.—Medium sized costellate shells having ventral valve deeper and more convex than the flat or nearly flat dorsal valve. Interareas unequally developed. Brachiophores contained in cuplike sockets.

Discussion.—This genus is very similar in form, outline and ornament to *Schuchertella* (*S. lens* White, 1862, type species) but differs in having a much reduced dorsal interarea and having no pseudopunctae. It is thus similar to *Eoschuchertella* Gratsianova (1974) but differs in cardinalia, as the Russian genus lacks the cuplike cardinalia and has a lesser development of the cardinal process. Gratsianova likens her genus to *Schuchertella* but her figures do not conform well to the Mississippian species; however, she makes clear that *Eoschuchertella* is not pseudopunctate. Her figures do not show the cuplike brachiophore supports and the cardinal process figured is more erect than that of *Schuchertella*. *Schuchertellopsis* Maillieux (1939) was erected for brachiopods of this type which are cemented to other shells. *Floweria* n. gen. has been found cemented to spiriferids. It is possible that *Schuchertellopsis* is close to, if not the same as, *Floweria* but the inner details are not known.

The American “schuchertellas”, as indeed all the related forms, are in great need of revision. The problem is complicated by the homeomorphic development of impunctate and pseudopunctate forms. Many of the species of the Early, Middle and early Late Devonian are impunctate while some of those of the latest Devonian (Famennian-Percha) are pseudopunctate. The pseudopunctate forms should not be classified with the impunctate ones as Havlíček (1967, p. 197) has done in making his composition of the Schuchertellidae.

The genus is named for Dr. Rousseau Flower, Socorro, New Mexico, who helped us in our field work and provided us with specimens from his own collecting in the Devonian of New Mexico.

***Floweria prava* (Hall)**

Plate 10, figures 15–27

Orthis prava Hall, 1858, p. 490.

Orthotetes prava (Hall) Hall and Clarke, 1892, p. 225, pl. 11A, fig. 13.

Schuchertella prava (Hall) Fenton and Fenton, 1924, p. 117, pl. 20, figs. 21–28; Stainbrook, 1945, p. 34, pl. 2, figs. 19, 20; ? 1948, p. 772, pl. 1, figs. 7, 8.

This is a variable species not only in the Hackberry Formation (Cerro Gordo Member) where it is best known, but also in the Sly Gap of New Mexico. These shells are cemented early in life; consequently, their ultimate shape depends in part on the nature of the host and their mode of growth later after they have broken from their attachment. The Sly Gap specimens agree well in ornament with the Iowa species, there being usually two costellae per mm, but in some parts of a shell there may be three costellae in a mm. *Floweria prava* commonly has an obtuse cardinal extremity but some are acute, nearly at a right angle, occasionally with a small and insignificant ear. So it is with the New Mexico specimens. A wide one (USNM 200855) has a small ear on one side and the other is broken. Most specimens from the Sly Gap Formation have obtuse cardinal extremities. The convexity of the dorsal valve is variable; most specimens are moderately convex but a fairly large number are flat or concave, probably a reflection of growth on an unusual host.

The pseudodeltidium of the New Mexico specimens is often minutely and fairly evenly wrinkled and a few specimens from the Hackberry show a similar wrinkling. No interiors of the New Mexico specimens were found.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 200855 (loc. 509h)	15.7	14.6	22.6?	23.2	6.0
USNM 200854 (loc. 509z)	15.7	14.6	16.7	20.0	6.4
USNM 201190 (loc. 509p)	17.2	16.7	21.8?	24.1	6.8
USNM 200874 (loc. 521e)	14.3	12.5	14.2	17.3	7.0

Diagnosis.—Small to medium flattish *Floweria* of subrectangular outline having two or three costellae in a mm at the anterior margins of adults, and with a flat to slightly convex dorsal valve.

Stratigraphic occurrence.—Sly Gap Formation; Hackberry Formation (Cerro Gordo Member).

Localities.—506c, i, j; 509i, n, p, s, v, x, z; 521c, e, m; 524m, n; 3054g.

Types.—Figured Hypotypes: USNM 200854, 200874.

Discussion.—The species is very rare in the Sly Gap Formation.

***Floweria* aff. *F. chemungensis* (Conrad)**

Plate 11, figures 1–5

Strophomena chemungensis Conrad, 1842, p. 257, pl. 14, fig. 12.

Streptorhynchus chemungensis (Conrad) Hall, 1867, p. 67, pl. 10.

This large, misshapen *Floweria* is very different from *F. prava*. The specimen measures 25 mm in length and 30.2 mm in width, but its right side is narrower than the left (seen from the ventral side) apparently due to impingement against some obstacle to its uniform growth. The growth of this shell was very uneven at the beak as well as at the sides. The beak is elongated and narrow with a narrow interarea for half its length but the interarea suddenly widens to measure 14.5 mm on the left side (seen from the dorsal side) of the shell; but it is only 9.7 mm wide on the right side. In lateral view, the ventral valve is resupinate; the dorsal valve is fairly strongly convex at midvalve but is flattened anteriorly. The primary costellae are narrowly rounded and are separated by one or two costellae of lesser strength. Nine or ten costellae occupy a space of five mm at the front margin.

Interior not seen.

Diagnosis.—Fairly large, irregularly shaped *Floweria*, having a resupinate ventral valve, with nine or ten costellae in five mm at the anterior.

Stratigraphic occurrence.—Contadero Formation (top).

Locality.—523n.

Types.—Figured Hypotype: USNM 200875.

Discussion.—This specimen suggests relationship to *Schuchertella* [= *Floweria*] *chemungensis* (Conrad) which also has a resupinate ventral valve. Although the eastern species is often larger and flatter, it has about the same type of ornament.

Two other fragmentary specimens of a large schuchertellid may belong here but they are not complete enough for identification. One is from the Rhodes Canyon Formation at locality 523p; the other comes from the Sly Gap Formation at locality 526n.

***Floweria transversalis* new species**

Plate 10, figures 41–46

About medium size for genus, widely rectangular in outline, length about two-thirds the width; concavo-convex; sides rounded; hinge slightly less wide than midwidth; anterior commissure narrowly flexed dorsally. Cicatrix of attachment occupying about half the surface of the ventral valve. Interarea moderately long; apsacline. Pseudodeltidium strongly convex. Surface costellate, costellae fairly uniform in size, three to a mm at the front margin.

Ventral valve fairly strongly concave and having large attachment surface; anterior profile nearly flat; cardinal extremities slightly deflected dorsally to form small obtuse ears. Anterior with narrow sulcus. Dorsal valve moderately convex in lateral profile and broadly convex in anterior profile. Median region with low narrow fold not extending posteriorly beyond midvalve. Umbo lateral slopes fairly steep and posterolateral extremities dorsally deflected.

Interior not known.

Measurements (in mm).—USNM 200873 (Holotype): length 19.0, dorsal valve length 16.7, hinge width 27.6, maximum width 30.5, thickness 7.3.

Diagnosis.—Concavo-convex *Floweria* having a large attachment surface, length two-thirds the width, anterior commissure uniplicate.

Stratigraphic occurrence.—Independence Formation.

Locality.—362a.

Types.—Holotype: USNM 200873.

Discussion.—Compared to the largest specimen of *F. prava* (Hall, 1858) from Rockford, Iowa, and vicinity, which has similar length-width dimensions, the Independence specimen is ventrally concave, rather than convex as is the Hackberry specimen. The dorsal valve of the Independence specimen is much more convex than *F. prava* from Rockford. The volumes of the valves of the Hackberry species are the reverse of those of the specimen from the Independence Formation.

***Floweria magnacicatrix* new species**

Plate 10, figures 28–33

About medium-sized, rectangular in outline, length about two-thirds width. Cardinal extremities with small ears; sides gently rounded; valves convexo-concave. Hinge straight, slightly wider (see "Discussion") than midwidth; interarea strongly apsacline, moderately

long; pseudodeltidium strongly convex. Anterior commissure with a broad dorsal fold. Surface costellate, costellae narrowly rounded, strong, about four in five mm at the anterior of the dorsal valve, and separated by spaces slightly wider than the costellae.

Ventral valve depressed by a wide cicatrix that occupies more than half surface; anterior third forming a broad sulcus. Dorsal valve gently convex in lateral profile, most convex in umbonal region. Lateral slopes gentle; margins somewhat deflected and flattened.

Measurements (in mm).—USNM 200855 (Holotype): length 15.6, dorsal valve length 14.6, hinge width 22.8 plus, midwidth 23.2, thickness 5.2, height 6.4.

Diagnosis.—*Floweria* having a large cicatrix of attachment, widely rectangular outline, and strong costellation.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—509h.

Types.—Holotype: USNM 200855.

Discussion.—This species has characters suggestive of *Floweria prava* (Hall, 1858) and *F. transversalis*, n. sp. It resembles the former in outline but differs in having a wider hinge, more prominent fold and sulcus, stronger ornament, and much larger cicatrix of attachment. In the latter respect, *F. magnacicatrix* is like *F. transversalis* but the ornamentation of the Sly Gap species is stronger and the costellae are separated by wider interspaces.

Superfamily DAVIDSONIACEA W. King, 1850

Family SCHUCHERTELLIDAE Williams, 1953

Subfamily SCHUCHERTELLINAE Williams, 1953

Genus SCHUCHERTELLA Girty, 1904

Schuchertella percha (Stainbrook)

Plate 10, figure 47

Schuchertella chemungensis Kindle, 1909, p. 16, pl. 3, figs. 2–4a.

Schellwienella percha Stainbrook, 1947, p. 304, pl. 45, figs. 9, 12, 13.

Sectioning of the ventral beak of a specimen from locality 509b failed to show the pseudo-dental plates that usually characterize *Schellwienella* I. Thomas (1910). This Percha Formation (Box Member) species appears to be a true *Schuchertella* having a fairly uniform strophomenoid convexo-concave shape. A few specimens have a greater development of the interarea than typical and these have a somewhat distorted umbonal region, but the ornament is similar to the typical forms and there is no apparent reason to exclude them from the species.

The dorsal valve has a short but well-developed chilidium and the cardinal process is bilobed and mod-

erately elevated. The ridges producing the sockets are fairly thick. A poorly developed myophragm appears anterior to the cardinal process. This species grows to a much larger size than indicated by Stainbrook.

The species is strongly and finely pseudopunctate and thus must be assigned to *Schuchertella* rather than to *Floweria*.

Measurements (in mm).—A large and fairly symmetrical specimen (USNM 201133) from locality 3026a measures: length 27.3, dorsal valve length 23.2, hinge width 27.0, maximum width 32.1, and thickness 8.3.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b; 507a, b, h, o, v; 509, b; 527a, d, p; 3026, 3026a; 3034; 3035; 3042.

Types.—Figured Hypotype: USNM 201133.

Schuchertella resupinata new species

Plate 10, figures 34–36

About usual size for genus, transversely and broadly elliptical in outline, sides rounded; maximum width at or posterior to midvalve; hinge wide but not equalling maximum shell width. Interarea fairly long, nearly flat and strongly apsacline. Pseudodeltidium large and convex; chilidium well-developed, in close contact with the pseudodeltidium when the valves are closed. Surface costellate, costellae unequal in size, each succeeding generation of three intercalated ones smaller than preceding one and separated by spaces as wide or wider than costellae. Costellae of all generations numbering 13 in five mm at the front margin in interspaces occupied by closely crowded concentric fila.

Ventral valve with a sigmoidal lateral profile, the posterior umbonal region convex but the anterior becoming concave. Anterior profile having a narrowly domed median region with long flattened lateral slopes. Dorsal valve with concave umbonal region and convex anterior but flattened posterolaterally.

Interior not seen.

Measurements (in mm).—USNM 201189a (Holotype): length 23.0, dorsal valve length 16.2, hinge width 26.4, maximum width 29.3, thickness 9.0?.

Diagnosis.—Resupinate *Schuchertella* having 13 costellae in five mm at the anterior of an adult.

Stratigraphic occurrence.—Percha Formation (Box Member).

Locality.—509e.

Types.—Holotype: USNM 201189a. Unfigured Paratype: USNM 201189b.

Discussion.—This species differs from *Schuchertella percha* (Stainbrook, 1947) in having the posterior of the ventral valve strongly convex and the umbonal

region of the dorsal valve concave. Stainbrook's species is much more evenly convexo-concave, although the ornament is similar.

"*Schuchertella*" species

A small "*Schuchertella*" with a crushed dorsal valve has alternating fine and coarse costellae, one or two of the finer ones separated by the stronger costellae. The specimen is subrectangular, wider than long. The ventral valve is nearly flat and the dorsal valve fairly strongly convex. The specimen is too poorly preserved for satisfactory comparison with other species.

Measurements (in mm).—Length 13.8, dorsal valve length 11.7, hinge width 13.4, maximum width 17.8, thickness greater than 5.5.

Stratigraphic occurrence.—Oñate Formation.

Locality.—523u.

Types.—Described Specimen: USNM 201188.

Suborder **CHONETIDINA** Muir-Wood, 1955

Superfamily **CHONETACEA** Bronn, 1862

Family **CHONETIDAE** Bronn, 1862

Subfamily **DEVONCHONETINAE** Muir-Wood, 1962

Genus **DEVONCHONETES** Muir-Wood, 1962

Devonochonetes? species

Plate 10, figures 37–40

About medium size for genus, rectangular in outline, length about two-thirds midwidth; hinge forming the widest part; cardinal extremities acute. Sides nearly straight or slightly oblique; anterior margin broadly rounded. Posterior margin with at least three short, oblique spines. Surface finely costellate, five or six costellae in one mm.

Ventral valve gently convex in both profiles; median region gently swollen; slopes to cardinal extremities gently concave. Dorsal valve flatly concave.

Ventral interior with a long median septum; dorsal valve with a low, small, bilobed cardinal process with low median ridge.

Measurements (in mm).—

	length	hinge width	mid-width	thickness
USNM 203542 (loc. 527w)	12.5	18.2*	18.6	—
USNM 203543a				
USNM 201089a (loc. 526b)	11.1	19.8	16.4	—
	14.2	23.4	21.5	—

Diagnosis.—Finely costellate, thin *Devonochonetes* with length 65–70 percent of the midwidth.

Stratigraphic occurrence.—Oñate Formation.

Localities.—526b; 527w.

Types.—Figured Specimens: USNM 201089a, b; 203542; 203543a.

Discussion.—These specimens are so poorly preserved that they cannot be definitely identified as to genus or intelligently compared with any already described species.

Genus **STRIATOCHONETES** Mikryukov, 1968

Striatochonetes nanus new species

Plate 11, figures 13–18

Small, subrectangular in outline, wider than long; sides rounded; anterior margin broadly rounded. Hinge straight, narrower than maximum width, which is at midvalve; cardinal extremities obtusely rounded. Posterior margin with two or three short, oblique spines. Surface costellate, except for cardinal extremities; about 21 costellae on a side, increasing by implantation and bifurcation in three generations.

Pedicle valve moderately convex in lateral profile and broadly domed, but moderately elevated, in anterior profile. Umbonal and median regions swollen. Interarea fairly long, curved, orthocline to anacline. Pseudodeltidium short and convex.

Dorsal valve closely fitting the ventral valve and thus moderately concave. Interarea strongly hypercline. Chilidium thin and short; cardinal process trilobed, filling delthyrial cavity of ventral valve; median lobe of cardinal process grooved.

Ventral valve interior with long, thin median septum. Dorsal valve having small, slender prosocet ridges, small, thin, divergent anderidia and a thick median septum reaching to about midvalve. Lateral septa bifurcating near midvalve and dying on the anterior slope.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid-width	thickness	height
USNM 201077b (loc. 522d)	5.3	—	5.6	7.7	—	2.0
USNM 201078 (loc. 524g)	5.0	—	5.5	7.0	—	1.4
USNM 201079a (loc. 522i)	5.6	—	5.7	7.8	—	1.3

Diagnosis.—Small *Striatochonetes* having length 0.7–0.8 the width, and about 40 costellae.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522d, e, i; 523b, f, s, w, x; 524a, g, h, j, l; 526h; 529j, n; 3025a; 3053.

Types.—Holotype: USNM 201079b. Figured Paratypes: USNM 201077a, b; 201078a, b; 201079a. Unfigured Paratype: USNM 201079c.

Discussion.—This species resembles several small chonetids from the Devonian: *C. scitulus* Hall (1857), *C. setigerus* Hall (1843), *C. schucherti* Cleland (1911), *C. lepidus* Hall (1857), and *C. scitulites* Cooper (1945). The New Mexico species is smaller than all of these except *C. setigerus*, but the latter has erect cardinal spines rather than oblique ones.

***Striatochonetes subcarinatus* new species**

Plate 11, figures 6–12

Small, roundly elliptical in outline, strongly concavo-convex in lateral profile; sides strongly rounded and anterior broadly rounded. Hinge narrower than greatest width, which is at midvalve. Ventral interarea moderately long, curved, anacline; pseudodeltidium well-developed. Cardinal process with trilobed myophore bounded by small chilidial plates. Dorsal valve interarea short, hypercline. Surface costellate, costellae low, strongest on umbonal region, numbering about four in one mm at the anterior of the dorsal valve.

Ventral valve strongly convex in lateral profile, roundly carinate in anterior profile and with straight, steeply-dipping lateral slopes. Umbonal region subcarinate and marked by the strongest costellae. Dorsal valve deeply concave and with a deeply concave umbonal region. Deepest in midvalve and with steep slopes to midvalve.

Interior not known.

Measurements (in mm).—USNM 201080 (Holotype): length 6.8, dorsal valve length 5.5, hinge width 6.2, midwidth 8.3, thickness 1.5, height 3.8.

Diagnosis.—*Striatochonetes* with strongly convex and subcarinate anterior profile.

Stratigraphic occurrence.—Oñate Formation.

Locality.—523f.

Types.—Holotype: USNM 201080.

Discussion.—This species is about the same size as *Striatochonetes nanus* n. sp., but differs in being much more convex, especially in anterior view, in having finer costellae, a narrower hinge and a deeper dorsal valve. The species appears to be very rare.

Genus RETICHONETES Muir-Wood, 1962

***Retichonetes obscurus* new species**

Plate 11, figures 19–25

Small, transversely rectangular in outline; hinge wide but narrower than maximum shell width which is at about midvalve; sides rounded; anterior margin broadly rounded; posterior margin bearing two or three slender, long (2.25 mm) vertical spines. Interarea short, apsacline; delthyrium closed by convex pseudodeltidium; notothyrium plugged by cardinal process; small

remnantal chilidium present. Surface costellate, costellae rounded and separated by interspaces narrower than costellae, about five costellae in one mm at anterior of an adult specimen.

Ventral valve moderately strongly convex in lateral profile; broadly but unevenly convex in anterior profile, the median region swollen and the sides descending steeply but lessening to gently concave toward the cardinal extremities. Umbonal region not strongly swollen and not protruding posteriorly beyond the posterior margin.

Dorsal valve closely fitting into ventral valve and having its most concave part slightly posterior of midvalve; cardinal extremities slightly concave; slopes to midvalve steepest laterally but less so at the anterior.

Interior of ventral valve with median septum reaching to about one-third valve length. Dorsal valve having short prosocket ridges and unusually thick andridia; entire anterior half strongly pustulose. Cardinal process having two central ridges and one on each side of the central pair.

Measurements (in mm).—

	dorsal valve length	length	hinge width	mid- width	surface length	thick- ness
USNM 201177 (loc. 527f)	5.5	4.6	6.0	7.3	6.5	0.8
USNM 201124 (loc. 506q)	5.0	4.6	6.9	6.2	6.0	0.7

Diagnosis.—Small, moderately convex *Retichonetes* having five costellae in one mm at the front margin.

Stratigraphic occurrence.—Percha Formation (Ready Pay Member; Box Member).

Localities.—Percha Formation (Ready Pay Member): 3031; Percha Formation (Box Member): 506, b, p, q; 507o; 509b; 527f; 3043.

Types.—Holotype: USNM 201124a. Figured Paratypes: USNM 201115, 201116a. Unfigured Paratypes: USNM 201124b, 201177, 201116b.

Discussion.—This species differs from *Retichonetes perchaensis* n. sp. in being more transverse, less convex, and in having five costellae per mm rather than three. This species suggests *Chonetes scitulus* Hall (1857), which is common in eastern United States, but that species is a much smaller shell, differently ornamented, and is found low in the Middle Devonian. *Retichonetes nana* (Verneuil, 1845) from the Famennian (D 2/3) of central Russia has the same appearance as *R. obscurus* but it too is larger, more convex and with stronger, more distant costellae.

***Retichonetes perchaensis* new species**

Plate 11, figures 26–36

Small, subquadrate in outline, wider than long with hinge forming widest part. Sides slightly oblique; anterior margin broadly and fairly strongly rounded. Hinge forming the widest part in perfect specimens; cardinal extremities forming small rounded ears. Interarea moderately long, apsacline; delthyrium covered by a small convex pseudodeltidium. Surface costellate; costellae broad, separated by narrower interspaces, three to one mm at the front margin of a large specimen.

Ventral valve strongly convex in lateral profile, strongly domed in anterior profile; sides steep. Umbonal region strongly swollen and protruding posterior to posterior margin. Median region swollen from posterior to anterior; anterior slope steep and strongly rounded. Dorsal valve deeply concave with greatest concavity in the median region.

Interior not known.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	surface length	thick- ness
USNM 201122 (Holotype; loc. 527p)	6.5	5.6	8.0	7.8	8.0	0.6
USNM 201117 (loc. 507o)	7.0	—	9.6*?	7.3	9.5	—
USNM 201119 (loc. 3043)	6.4	—	11.4*?	6.6	8.0?	—
USNM 201120 (loc. 506)	5.0	—	7.3	5.7	7.0?	—

Diagnosis.—Strongly swollen, subquadrate *Retichonetes* having three costae to the mm at the anterior of an adult.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b; 507m, o; 509a, e; 527d, p; 3043.

Types.—Holotype: USNM 201122. Figured Paratypes: USNM 201117, 201119, 201120, 201123.

Discussion.—This species differs from *Retichonetes obscurus* n. sp. in its more quadrate form, stronger convexity and less numerous costellae.

Genus RHYSSOCHONETES Johnson, 1970***Rhyssochonetes johnsoni* new species**

Plate 11, figures 37–43

Large for genus, rectangular in outline; wider than long, length about 70 percent of width; maximum width at about midvalve; sides rounded, anterior margin broadly rounded. Hinge wide, as wide as or slightly

greater than midwidth; cardinal extremities slightly obtuse or slightly acute. Interarea moderately long; delthyrium partially closed by convex pseudodeltidium. Posterior margin bearing a few needle-like spines, the longest spine at the cardinal extremity attaining a length of 3.0 mm on a specimen 6.5 mm long; another fairly long spine appearing about half way between terminal spine and beak. Other spines not seen. Surface of both valves finely costellate, the costellae overlaid by a layer of raised wavy concentric lines usually stronger than costellae and dominating ornament.

Ventral valve gently convex in lateral profile with maximum curvature in posterior; anterior flattened; anterior profile a broad, moderately convex arch with long lateral slopes. Dorsal valve moderately concave and fitting snugly into ventral valve.

Ventral valve interior with flat, stout teeth and a long slender median septum. Dorsal valve with thick socket ridges, deep pit beneath the cardinal process, which is small and quadrilobed.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	hinge width	thick- ness
USNM 201061b (loc. 526b)	8.2	—	11.7	10.0	—
USNM 201061c (loc. 526b)	7.0	—	9.1	9.6	—
USNM 201061e (loc. 526b)	7.0	—	10.3	9.4?	—
USNM 201061d (loc. 526b)	5.9	—	7.6	8.1	—
USNM 204953b (loc. 527x)	5.5	—	7.9	6.6	—

Diagnosis.—Large, strongly rugose *Rhyssochonetes* with length about three-quarters of the width.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522j, n, z; 524p, q, r; 526b; 527x; 529m.

Types.—Holotype: USNM 201081c. Figured Paratypes: USNM 204953a, b; 201081a, b, d, e. Unfigured Paratypes: USNM 201061a–k, 201081f–j.

Discussion.—This is a common species in the Oñate Formation in the Mud Springs Mountains and at Hermosa. The species is the largest of the genus so far found. It is much larger than the Tully *Rhyssochonetes aurora* (Hall, 1867), is differently shaped, and has a stronger concentric element in its ornament. *Rhyssochonetes johnsoni* n. sp. is larger than *R. bellarugosus* (Stainbrook, 1943) from the Cedar Valley Formation and is much differently ornamented. Stainbrook's species is costate rather than costellate and its concentric markings are coarse and distant. The New

Mexico species is also much larger and more strongly ornamented than *R. aurora solox* Johnson (1970) from the Denay Limestone of Nevada.

Specimens in the National collections having about the same size and type of ornamentation come from the Bituminous Shale Member of the Pine Point Formation of Northwest Territories, Canada. Specimens referred to *R. aurora* (Hall) have been described by McCammon (1960, p. 47, pl. 8, figs. 1, 2) from the Dawson Bay Formation of Manitoba.

Suborder **PRODUCTIDINA** Waagen, 1883

Superfamily **STROPHALOSIACEA** Schuchert, 1913

Family **STROPHALOSIIDAE** Schuchert, 1913

Subfamily **STROPHALOSIINAE** Schuchert, 1913

Genus **EOSTROPHALOSIA** Stainbrook, 1943

Eostrophalosia rockfordensis (Hall and Clarke)
Plate 12, figures 1, 2

Strophalosia rockfordensis Hall and Clarke, 1893, p. 316, pl. 17A, figs. 1-3.

Through the kindness of Mr. C. O. Levorson, Riceville, Iowa, we are able to reproduce here a dorsal interior of this rare species, which is the type species of *Eostrophalosia*. This specimen shows the deep sockets, the bilobed cardinal process and brevisseptum. The specimen is from the *Strophonella* Zone of the Cerro Gordo Member of the Hackberry Formation at locality 527y.

Types.—Figured Hypotype: USNM 200838.

Eostrophalosia inexpectata new species
Plate 12, figures 3-12

About normal size for genus, as now understood, transversely elliptical in outline with strongly rounded sides and rounded anterior margin; hinge narrower than maximum width, which is at about midvalve. Interarea anacline, moderately long; delthyrium provided with wide, flat pseudodeltidium; dorsal valve interarea moderately long but shorter than that of ventral valve, hypercline. Notothyrium covered by short, low chilidium. Cicatrix of attachment small. Ventral valve strongly and closely nodose, each node bearing a fairly long slender spine; dorsal valve marked by rugae and nodes bearing long, slender spines.

Ventral valve fairly strongly and evenly convex, with a rounded, swollen umbonal region moderately protuberant beyond posterior margin; anterior profile high narrow dome with strongly sloping sides. Lateral slopes steep, those to the cardinal extremities steep and slightly concave.

Dorsal valve deeply concave, with all slopes steeply dipping to midvalve; cardinal extremities slightly concave at the indistinct ears. Umbo a flattish smooth circle.

Interior not seen.

Measurements (in mm).—USNM 200926 (Holotype; loc. 509r): length 11.7, dorsal valve length 9.4, hinge width 8.8, midwidth 14.0, surface length 19.0, thickness 2.7, and height 5.9.

Diagnosis.—*Eostrophalosia* of moderate size having slender spines on both valves, a deeply concave dorsal valve, and the length about 80 percent of the width.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—509r.

Types.—Holotype: USNM 200926.

Discussion.—The three known species of this genus are all unlike the present one. *Eostrophalosia inexpectata* (Stainbrook, 1945) is a much smaller species with more delicate spines, a wider hinge and a proportionately larger cicatrix of attachment. *Eostrophalosia rockfordensis* (Hall and Clarke, 1893) is a smaller species with rounder outline than that of *E. inexpectata*. *Eostrophalosia pedderi* Crickmay (1963) is a much larger species with stronger spines. The Sly Gap form is a very rare species, only one good specimen and two fragmentary ones having been collected.

Eostrophalosia species 1

Incomplete specimens from the Oñate Formation have an apical cicatrix and closely crowded spines. The specimens suggest *E. pedderi* Crickmay (1963) but the spines are more closely crowded and the specimens are larger.

Localities.—522g, i; 523e; 3025a.

Types.—Mentioned Specimen: USNM 201176.

DICHACAENIA new genus

[Gr. *dichas*, half; *akaeinia*, thorn]

Concavo-convex, subrectangular Strophalosiacea having a non-spinose dorsal valve and a ventral valve with scattered recumbent spines. Ventral valve interior with strong teeth. Dorsal valve interior with sockets for the teeth, a median septum and widely bilobed cardinal process.

Type species.—*Dichacaenia perplexa* n. sp.

Diagnosis.—Strophalosiids of medium size, moderately concavo-convex with sparsely spinose ventral valve and dorsal valve without spines.

Comparison.—A genus close to this one is *Eostrophalosia* Stainbrook (1943), which differs from *Dichacaenia* in having a completely spinose dorsal valve

whereas that of the new genus is without spines. The dorsal valve of *Eostrophalosia* is like that of *Dichacaenia* in having a widely bilobed cardinal process that differs from most of the early strophalosiids that have a cardinal process with laterally compressed lobes.

The exterior characters of the new genus suggest *Heteralosia* R. H. King (1938) in having a spiny ventral valve but non-spinose dorsal valve. However, the cardinal process of *Heteralosia* is of the laterally compressed type and is entirely different from the open, bilobed cardinal process of *Dichacaenia*.

Dichacaenia differs from *Cyphotalosia* Carter (1967) that has a non-spinose dorsal valve, in its larger size, different shape, flat pseudodeltidium and aberrant cardinal process.

The same features distinguish *Dichacaenia* from *Devonalsia* Muir-Wood and Cooper (1960) which has a narrowly compressed cardinal process like that of young *Heteralosia*. Another distinction that separates *Devonalsia* from the new genus is the large cicatrix of attachment, which in *Devonalsia* may involve nearly the entire surface of the ventral valve, as in *D. wrightorum* Muir-Wood and Cooper (1960). The cicatrix of *Dichacaenia* is small and no specimens were found attached; this suggests that the adult lived loose on the bottom, torn from its moorings early in life.

***Dichacaenia perplexa* new species**

Plate 12, figures 47–55

Moderately large, attaining a width of almost an inch (24 mm); subrectangular in outline with rounded sides and a broadly rounded anterior margin. Hinge wide but not equalling the midwidth, which is the widest part. Cardinal extremities obtusely rounded. Shell concavo-convex. Interareas on both valves well developed but that on the ventral valve being the longer and orthocline to anacline; dorsal interarea anacline. Pseudodeltidium and chilidium not developed. Beak having a small scar of attachment. Surface of ventral valve smooth and spinose, spine bases short and narrow, spines scattered fairly evenly but distantly over surface; spines recumbent, slender, and at least four mm long. Dorsal valve without spines, but in places dimpled corresponding to the spine bases of the opposite valve.

Ventral valve evenly and gently convex in lateral profile; anterior profile moderately strongly domed. Umbonal region small, narrowly swollen, only slightly protuberant beyond the posterior margin. Posterolateral slopes slightly concave; anterior slope fairly steep.

Dorsal valve moderately concave, most so slightly anterior to midvalve; posterolateral extremities moderately concave.

Ventral valve interior with stout teeth; dorsal valve with bilobed sessile cardinal process.

Measurements (in mm).—

	dorsal length	valve length	hinge width	mid- width	sur- face length	thick- ness	height
USNM 200957a (Holotype; loc. 523o)	17.6	16.0	17.5	23.3	22.5	3.2	6.0
USNM 200957d (loc. 523o)	16.0	14.6	15.2	18.7	19.0	2.2	4.7

Diagnosis.—Large *Dichacaenia* having low convexity and fairly evenly scattered, recumbent spines.

Stratigraphic occurrence.—Oñate Formation.

Localities.—523e; 523j, o.

Types.—Holotype: USNM 200957a. Figured Paratype: USNM 200957b. Unfigured Paratypes: USNM 200957c–g.

Comparison.—This species differs from *Devonalsia wrightorum* Muir-Wood and Cooper (1960), which is of about the same size, in the smaller cicatrix and the different spination. It differs from *Eostrophalosia rockfordensis* (Hall and Clarke, 1893) in its larger size and more spreading form. From *Eostrophalosia pederi* Crickmay (1963), this Oñate form differs in its flatter and wider shell and more scattered spines.

Dichacaenia perplexa n. sp. differs from *D. umbonata* n. sp. in its flatter umbonal region and less convex ventral valve.

***Dichacaenia umbonata* new species**

Plate 12, figures 41–46

Fairly large, elliptical in outline, wider than long; sides rounded; anterior margin broadly rounded. Hinge narrower than the maximum width, which is at midvalve. Cicatrix of attachment small. Median region swollen; umbonal region only slightly protuberant, but broad and swollen. Posterolateral slopes short; cardinal extremities somewhat flattened. Surface covered by short, distantly scattered, recumbent spines.

Dorsal valve exterior without spines and flatly lamellose. Dorsal valve interior with long slender brevisseptum reaching to midvalve, expanding posteriorly but not reaching the cardinal process; socket narrow, moderately deep. Cardinal process small, widely bilobed.

Measurements (in mm).—

	dorsal length	dorsal valve length	hinge width	maxi- mum width	thick- ness	surface length
USNM 201012a (loc. 523s)	17.8	—	19.5?	25.7	—	23.0
USNM 201012b	13.3	—	15.0?	21.3	—	20.0

Diagnosis.—*Dichacaenia* with swollen ventral umbonal region.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522j; 523b, i, s, t, u, z; 526c, 529j.

Types.—Holotype: USNM 201012a. Figured Paratypes: USNM 201012b, d; 201013; 204954. Unfigured Paratypes: USNM 201012c, e–i.

Comparison.—This species differs from *D. perplexa* n. sp. in having a larger size, more inflated ventral valve, and wider, more swollen umbonal region. The material on which this species is based is scanty and preservation is not the best. Only two specimens preserve the exterior of the dorsal valve.

Superfamily **PRODUCTACEA** Gray, 1840

Family **PRODUCTELLIDAE** Schuchert, 1929

Subfamily **PRODUCTELLINAE** Schuchert, 1929

Genus **PRODUCTELLA** Hall, 1867

Productella rugatula Stainbrook

Plate 12, figures 13–20

Productella rugatula Stainbrook, 1945, p. 36, pl. 3, figs. 48, 49; 1948, p. 772, pl. 1, figs. 20–22.

This is a small productellid having a subcircular outline, with rounded sides and anterior; hinge narrower than maximum width. The interarea is short and narrow. The cardinal extremities form small, obtuse ears. The ventral umbonal region is narrowed and swollen, with irregular concentric wrinkles. Concentric wrinkles appear infrequently on the shell body but are prominent along the posterior margin. The spines of the ventral valve are scattered, variable in number and strength. All parts of the ventral valve have spines but there seems to be little system to their arrangement. They are present on the ears, lateral and anterior slopes, median and umbonal regions; one specimen may be more abundantly adorned in one part than another. The spines have a length of seven mm on a shell only eight mm long. The dorsal valve closely follows the concavity of the ventral valve and is dimpled in places corresponding to the position of spines on the opposite valve.

Measurements (in mm).—

	dorsal length	dorsal valve length	hinge width	maxi- mum width	sur- face length	thick- ness	height
USNM 201175a (loc. 509n)	11.0	9.8	11.0?	12.5	16.0	3.0	6.1
USNM 201175b (loc. 509n)	11.4	9.6	8.8	11.8	17.0	2.8	5.7

Diagnosis.—Small *Productella* having variable spine adornment.

Stratigraphic occurrence.—Sly Gap Formation; Independence Formation.

Localities.—506c; 509h, j, l, n, s; 521c, d, e, k, m, p, r, s, v, w; 522k; 524m, w; 526n.

Types.—Figured Hypotypes: USNM 201118, 201120.

Discussion.—This is a rare and unsatisfactory species because of its invariably poor preservation. Few of the specimens preserve spines and most of those having both valves in contact are broken around the margins. Furthermore, the shells are variable, not only in the spine arrangement but also in presence of concentric wrinkles. A few specimens have the umbonal region fairly crowded with spine bases.

The holotype was described by Stainbrook from the Independence Shale at Brandon, Iowa.

***Productella* species 1**

Plate 12, figures 29–40

Small to medium for genus, subquadrate in outline, wider than long; hinge narrower than midwidth; cardinal extremities obtuse; interarea short and narrow. Ventral valve strongly convex especially in the umbonal region, which is narrowly curved and strongly protuberant beyond the posterior margin; anterior profile high dome with nearly straight, precipitous sides. Dorsal valve deeply concave, most so at midvalve. Ventral valve surface marked by concentric undulations on the umbonal and posterior regions, and by long slender spines scattered distantly on surface, and without elevated bases. Anterior marked by occasional short costae, more numerous on lateral slopes. Dorsal valve without spines but with concentric undulations on posterior margins and around umbonal pit.

Interior of dorsal valve with long slender brevisep-tum.

Measurements (in mm).—

	dorsal valve length	hinge width	maxi- mum width	sur- face length	thick- ness	height
USNM 201011b (loc. 521h)	14.0	11.2	11.7	16.7	24.0	— 8.5
USNM 201011a (loc. 521h)	13.0	11.9	13.3	14.7	23.0	— 7.0
USNM 203563a (loc. 527z)	12.4	—	11.4	15.0	21.0	— 7.0

Diagnosis.—Small to medium-sized *Productella* with distantly scattered spines and length about 85 percent of width.

Stratigraphic occurrence.—Rhodes Canyon Formation.

Localities.—509t, u; 521h; 524e; 527z; 3054g, q.

Types.—Figured Specimens: USNM 201011a, b; 203563a–c.

Discussion.—These specimens cannot be identified with any described species but they are too poor to use as the basis for a new species. They are much larger than *P. rugatula* Stainbrook (1945). The illustrated specimens suggest *P. thomasi* Stainbrook (1945) but are larger than that species and have a greater development of costae anterior to the spines.

***Productella?* species 2**

Plate 11, figures 44–46

Large for genus, subquadrate in outline and with subparallel sides and rounded anterior margin. Strongly convex, the greatest convexity at midvalve; anterior and posterior slopes steep; umbonal region swollen and strongly protuberant beyond the posterior margin. Interarea short; hinge narrower than midwidth. Surface marked by numerous slender spines, usually with small bases, but anteriorly the spines have interrupted elongate ridges on their anterior sides that give the impression of anterior costellation.

Measurements (in mm).—USNM 201143a: length 26.0, dorsal valve length 22.0, hinge width 14.0, maximum width 26.6*, surface measure 43.0, thickness unknown, height 14.0.

Stratigraphic occurrence.—Contadero Formation.

Localities.—Contadero: 509u; 523n. Probably Contadero: 528o.

Types.—Figured Specimen: USNM 201143a.

Discussion.—Three lots of large *Productella* are so poorly preserved that they cannot be satisfactorily described. The measured and illustrated specimen is the best preserved, but it is damaged on one side. We have been unable to make a satisfactory comparison of this species with any form described by Hall from the Upper Devonian of New York.

***Productella* species 3**

Plate 13, figure 1

A single specimen of *Productella* was collected from the Thoroughgood Formation (loc. 522). It is so poorly preserved that nothing but its outline is definite.

Types.—Figured Specimen: USNM 201086.

Subfamily **CHONOPECTINAE** Muir-Wood and Cooper, 1960

Genus **ACANTHATIA** Muir-Wood and Cooper, 1960

***Acanthatia nupera* (Stainbrook)**

Heteralosia nupera Stainbrook, 1947, p. 309, pl. 46, figs. 16, 17.

Acanthatia nupera (Stainbrook) Muir-Wood and Cooper, 1960, p. 158, pl. 38, figs. 1–14.

This species was inadequately figured by Stainbrook but later was described in detail by Muir-Wood and Cooper (1960). Its cardinal process is productellid rather than strophalosiid and the genus is now placed in the Productellidae. It is not a common fossil in the Box Member except at locality 506b (=507o).

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, a, b, p, q; 507a, h, m, o, r; 509a, b; 527e, f, p; USGS (Kirk) 508; 3026, a; 3029, 3034 = 507h; 3035; 3042.

Types.—Holotype: M.A.S. 1598a (=USNM 135240). Figured Paratype: M.A.S. 1598b (=USNM 135241). Figured Hypotypes: USNM 123437, 123438a–e, g, 123921a, 123922. All types figured by Stainbrook (1947).

Family **LEIOPRODUCTIDAE** Muir-Wood and Cooper, 1960

Subfamily **LEIOPRODUCTINAE** Muir-Wood and Cooper, 1960

Genus **LEIOPRODUCTUS** Muir-Wood and Cooper, 1960

***Leioproductus plicatus* (Kindle)**

Productella coloradensis var. *plicatus* Kindle, 1909, p. 18, pl. 4, figs. 9–11, ?12.

Leioproductus plicatus (Kindle) Stainbrook, 1947, p. 308, pl. 46, figs. 21–23; Muir-Wood and Cooper, 1960, p. 168, pl. 40, figs. 1–12.

This is a small, rather smooth productid having a median plica or median row of spines; it is common at many localities. It is difficult to distinguish *L. plicatus* from *L. coloradensis* (Kindle, 1909), which is very rare in New Mexico. Evidently, Stainbrook selected this “variety” as type species for *Leioproductus* because of its abundance as compared to the paucity of numbers of *L. coloradensis*.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b, p, q; 507a, b, c, d, g, h, k, l, m, n, o, q, t, v, w; 509, a, b; 527d, e, f, g, p; 3026, a; 3029; 3034; 3035; 3042, s; USGS (Kirk) 508; 512.

***Leioproductus defessa* (Stainbrook)**

Avonia defessa Stainbrook, 1947, p. 309, pl. 46, figs. 6, 7.

The single specimen described and figured by Stainbrook is the only one of this species that we have seen. Although we have extensive collections from the type section of the Percha Formation (Box Member, locality 507h), from which *A. defessa* came, no other specimen like *A. defessa* has appeared. The unusual feature of *A. defessa* is the development of costae anterior to the spine bases which give the appearance of costae, the development of which on the anterior slope of a productid is a distinguishing character of *Avonia* Thomas (1914). Stainbrook's specimen has umbonal undulations which are not usually present on *Avonia*. The entire aspect of Stainbrook's specimen is that of *Leioproductus* Muir-Wood and Cooper (1960), but its spines are finer than those seen on most specimens of *Leioproductus*.

Types.—Holotype: M.A.S. 1612 (=USNM 135255).

***Leioproductus coloradensis* (Kindle)**

Productella semiglobosa Girty, 1900, p. 42, pl. 3, figs. 7–10.

Productella coloradensis Kindle, 1909, p. 17, pl. 4, figs. 2–8.

Leioproductus coloradensis (Kindle) Stainbrook, 1947, p. 308, pl. 46, figs. 18–20.

This is a much less common species in New Mexico than *Leioproductus plicatus* (Kindle, 1909) and may be identified by its lack of either a median plica or vertical row of spines on the ventral valve. Stainbrook's figured specimens were not received by the U.S. National Museum of Natural History in the gift of his Percha collection.

Stratigraphic occurrence.—Ouray Formation (in Colorado); Percha Formation (Box Member).

Localities.—Rockwood, Colorado; 507h.

Types.—Holotype: USNM 62009c. Paratypes: USNM 62009a, b, d, e. Figured Hypotypes: USNM 155811–3 (=M.A.S. 1606). Types figured by Stainbrook (1947).

***Leioproductus pauperculus* new species**

Plate 12, figures 21–28; plate 13, figures 2–9

Small for genus, quadrate in outline, slightly wider than long; sides slightly oblique to rounded; anterior margin broadly rounded; hinge wide, slightly narrower than midwidth, in well-preserved specimens. No interareas. Surface smooth except for spines and concentric wrinkles. Spines fairly long, scattered, leaving rounded bases, when broken, that seldom have anterior ridges. A few spines located on ears and posterior margin, a few on the lateral slopes and a few on the anterior slope, in some specimens forming an indistinct row. Concentric undulations generally fairly wide and located chiefly in umbonal region.

Ventral valve with strongly swollen umbo protruding well beyond hinge line. Lateral profile strongly convex especially in umbonal region where it forms a semicircle. Anterior profile a strongly convex dome with very steeply sloping sides. Anterior slope long and moderately steep. Ears small and rounded.

Dorsal valve smooth, with few concentric undulations best developed in the vicinity of the hinge and ears. Valve deepest posteromedially, and all slopes dipping steeply to the middle; umbonal region a deep pit.

Interior not known.

Measurements (in mm).—

	dorsal valve length	hinge length	mid- width	thick- ness	surface length	height
USNM 201111 (loc. 506p)	10.4	—	9.4*	11.3	—	17.0 7.0?
USNM 201110a (loc. 506)	10.2	—	10.5	11.8	—	17.5 6.8
USNM 201112 (loc. 509a)	11.5	9.3	10.7	13.0	2.7	18.5 6.0

Diagnosis.—Small *Leioproductus*, with length 0.9 the width, having umbonal region of ventral valve with concentric undulations and scattered distant spines on the surface.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b, p, q; 507b, c, h, k, m, n; 509, a, b, c; 527d, e, p; 3026; 3042, s.

Types.—Holotype: USNM 201112a. Figured Paratypes: USNM 201110a, 201111. Unfigured Paratypes: USNM 201110b, 201112b–d.

Discussion.—This species can be recognized by its small size and scattered spines. It differs from both *L. coloradensis* (Kindle, 1909) and *L. plicatus* (Kindle, 1909) in its size, nearly equal length and width, more numerous spines and less strong concentric undulations. The species is rare.

Leioproductus varispinosus (Stainbrook)

Productella coloradensis var. *plicatus* Kindle, 1909 (part), pl. 4, fig. 13 (not figs. 9, 10–11a).

Bispinoproductus varispinosus Stainbrook, 1947, p. 311, pl. 46, figs. 30–33.

Leioproductus varispinosus (Stainbrook) Muir-Wood and Cooper, 1960, p. 168, pl. 40, figs. 14–25.

Muir-Wood and Cooper (1960, p. 168) put this species in *Leioproductus* Stainbrook (1947) when they suppressed *Bispinoproductus* Stainbrook (1947), which is regarded as a synonym of *Leioproductus*. This is a large productid, easily distinguished from the other species by its more numerous spines, larger size and more strongly geniculated profile.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, a, b, p, q; 507a, b, c, f, h, m, n, o, p; 509, a, b, e; 527a, d, e, f, g, l, p; 3026, a; 3029; 3031b; 3034; 3042, s.

Types.—Holotype: USNM 155786. Paratype: USNM 155787. Primary types figured by Stainbrook (1947). Figured Hypotypes: USNM 123947a, b; 123945a, b; 123948. All types in U.S. National Museum of Natural History.

Genus GALEATELLA Muir-Wood and Cooper, 1960**Galeatella galeata** Muir-Wood and Cooper

Galeatella galeata Muir-Wood and Cooper, 1960, p. 174, pl. 41, figs. 15–24.

This is a fairly large, smooth leioproductid having a broad sulcus at the anterior. It is an uncommon species.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, a, b, p, q; 507a, b, h, k; 509b, c; 527d; USGS (Kirk) 461; 3026, a; 3034; 3042.

Types.—Holotype: USNM 123447. Figured Paratypes: USNM 123448a, b; 123449a, b. Types figured in Muir-Wood and Cooper (1960).

Genus PLANOPRODUCTUS Stainbrook, 1947**Planoproductus hillsboroensis** (Kindle)

Productella hillsboroensis Kindle, 1909, p. 19, pl. 5, fig. 6.

Planoproductus hillsboroensis (Kindle) Stainbrook, 1947, p. 310, pl. 46, figs. 27–29; Muir-Wood and Cooper, 1960, p. 176, pl. 42, figs. 1–15.

This is the largest of the Devonian productids so far described in North America and can be readily recognized even from fragments. It is an uncommon species.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, a, b, q; 507a, g, h, m, n, o; 527d, f, p; 3026; 3029; 3025; 3042, s.

Types.—Holotype: USNM 62017. Hypotypes figured by Stainbrook (1947) and Muir-Wood and Cooper (1960): USNM 155793–4 (=M.A.S. 1590); USNM 123440; 123441; 123443; 123444a; 123942; 123943a.

Subfamily DEVONOPRODUCTINAE Muir-Wood and Cooper, 1960**Genus DEVONOPRODUCTUS** Stainbrook, 1943**Devonoproductus intermedius** new species

Plate 13, figures 36–56

Medium size for genus, squarish in outline with length and width nearly equal; sides gently rounded to subparallel; anterior margin strongly rounded; cardinal extremities forming small obtuse ears. Interarea short and strongly curved; beak small, incurved and moderately protuberant beyond the posterior margin. Ventral valve surface finely costellate and spinose; costellae low, crowded, wider than interspaces and numbering four to one mm at the anterior margin of large adult; spines small, distant, scattered on shell body, sparse on ears. Dorsal valve lamellose, lamellae closely crowded, about three to one mm and about 26 in shell 12 mm long; lamellae crowded at anterior.

Ventral valve moderately convex in lateral profile, most so at umbo, which is narrowly rounded; anterior profile fairly strongly convex and having steep lateral slopes. Umbonal region narrowly rounded and swollen, the swelling extending to midvalve and then decreasing anteriorly. Posterolateral slopes steeply descending to the slightly rounded ears.

Dorsal valve moderately concave, most so at about midvalve; lateral and anterior slopes descending moderately steeply toward valve center. Umbonal region slightly concave; ears flattened.

Ventral valve interior not seen. Dorsal valve interior having a long, slender brevisseptum and small cardinal process with myophore lobes separate. Posterolateral, lateral and anterior slopes marked by nodes or short endospines, the latter concentrated on the anterior slope.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maximum width	surface length	thick- ness
USNM 201027a (Holotype; loc. 509n)	14.1	12.1	12.3	14.6	21.0	4.7
USNM 201027b (loc. 509n)	12.0	10.3	10.4	12.6	16.0	3.2
USNM 201027c	11.1	9.9	9.4	11.6	14.0	3.2
USNM 201027d	11.2	10.0	9.1	11.2	16.0	3.2

	length	dorsal valve length	hinge width	maximum width	surface length	thick- ness
USNM 201051a (loc. 506j)	12.5	11.0	10.0	12.9	18.5	3.8
USNM 201045a (loc. 521e)	11.0	—	9.6	11.3	16.0	—
USNM 201174a (loc. 521k)	10.8	10.0	8.5	11.4	14.0	2.9

Diagnosis.—*Devonoproductus* of medium size having numerous overlapping lamellae on the dorsal valve.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, j; 509n, q, r, s, z; 521d, e, k, m, p, q, r, u, w; 522k; 524m, n; 526g, k, n; USGS (Kirk) 534; 538.

Types.—Holotype: USNM 201027a. Figured Paratypes: USNM 201027d; 201045a; 201051a; 201052a; 201058. Unfigured Paratypes: USNM 201027b, c; 201045b; 201051b; 201052b.

Discussion.—This species is intermediate between the Independence Formation species, *D. vulgaris* Stainbrook (1945) and *D. walcotti* (Fenton and Fenton, 1924) from the Cerro Gordo Member of the Hackberry Formation. *Devonoproductus intermedius* differs from the first in its larger size, less deeply concave dorsal valve, less elongated and elevated umbonal region, and less pronounced ears. It differs from *D. walcotti* in being smaller, less inflated, having a less deep dorsal valve, and much finer and more numerous overlapping lamellae on the dorsal valve. *Devonoproductus intermedius* differs from *D. hallianus* (Walcott, 1884) from the Eureka District, Nevada, in its smaller size, less depth, less protuberant and narrower umbo of the ventral valve and more crowded dorsal lamellae.

Devonoproductus intermedius is a fairly common and distinctive fossil in the Sly Gap Formation and the genus is one of the more characteristic of Frasnian fossils.

Devonoproductus vulgaris Stainbrook

Devonoproductus vulgaris Stainbrook, 1945, p. 37, pl. 3, figs. 44, 51–54.

Four specimens taken from the Sacramento Mountains conform to Stainbrook's species because they have high, narrow umbonal regions and a strong, almost subcarinate anterior profile. Unfortunately, no dorsal valve is available to check its degree of concavity and lamellation.

Diagnosis.—Small *Devonoproductus* with strongly swollen ventral valve, swollen umbonal region, deeply concave dorsal valve and variable lamellation on the dorsal valve.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c; 509v, w.

Types.—Stainbrook Hypotype: USNM 135282.

Discussion.—Stainbrook's specimen came from locality 506c.

Family OVERTONIIDAE Muir-Wood and Cooper, 1960

Genus LAMINATIA Muir-Wood and Cooper, 1960

Laminatia laminata (Kindle)

Productella laminatus Kindle, 1909, p. 18, pl. 4, figs. 13, 14.

Echinoconchus laminatus (Kindle) Stainbrook, 1947, p. 314, pl. 46, figs. 3–5.

Laminatia laminata (Kindle) Muir-Wood and Cooper, 1960, p. 189, pl. 41, figs. 1–14.

This is a small member of the Overtoniidae having strong lamellae bearing spines and thus shows a homeomorphic development toward *Echinoconchus* S. Weller (1914). It is generally a rare species.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b, p, q; 507a, b, h, k, m, q, z; 509, a, b, e; 527a, d, e, p; USGS 508; 3026a; 3042, s.

Types.—Holotype: USGS 62014a. Paratype: USNM 62014b, figured in Kindle (1909). Hypotypes figured in Stainbrook (1947): M.A.S. 1588a, b (=USNM 135247a, b). Hypotypes figured in Muir-Wood and Cooper (1960): USNM 123955a; 123956a, c; 123957; 124127.

Genus SENTOSIA Muir-Wood and Cooper, 1960

Sentosia praecedens (Stainbrook)

Productella spinigera (part) Kindle, 1909, pl. 5, figs. 2, 2a, b.

Pustula praecedens Stainbrook, 1947, p. 312, pl. 46, figs. 24–26.

Sentosia praecedens (Stainbrook) Muir-Wood and Cooper, 1960, p. 196.

This species is distinguished from *S. praecursor* (Stainbrook, 1947) by its greater convexity, fewer spines, and obscure concentric bands. It is a commoner species than *S. praecursor* but is rather rare nevertheless.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b, p, q; 507d, h, m, n, o; 509a, b, e; 527, d, e, p; 3026; 3029; 3042, s. USGS 461, 510.

Types.—Holotype: M.A.S. 1610a (=USNM 135242). Figured Paratype of Stainbrook (1947): M.A.S. 1610b (=USNM 123243). Paratype of *Productella spinigera* Kindle (1909): USNM 62015d.

Sentosia praecursor (Stainbrook)

Productella spinigera Kindle (part), 1909, pl. 5, fig. 4.

Krotovia praecursor Stainbrook, 1947, p. 313, pl. 46, figs. 11–15.

Sentosia praecursor (Stainbrook) Muir-Wood and Cooper, 1960, p. 196, pl. 43, figs. 8–22, text-fig. 7c.

Muir-Wood and Cooper proposed this species for the type of their genus *Sentosia*, a very distinctive form because of its fine mat of spines and broadly flattened anterior.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b, p, q; 507o; 509a, b, e; 527c, d, f; USGS (Kirk) 461, 510; 3026a, 3042s.

Types.—Holotype: M.A.S. 1609A = 155790. Figured Paratype: M.A.S. 1609 = 155791, primary types figured in Stainbrook (1947). Unfigured Paratype: USNM 155972. Figured Paratype of *Productella spinigera* Kindle (1909) = USNM 62015c. Hypotypes figured by Muir-Wood and Cooper (1960): USNM 123959a, b; 123968a, b; 124174.

Sentosia spinigera (Kindle)

Productella spinigera Kindle, 1909, p. 19, pl. 5, fig. 1.

Krotovia spinigera (Kindle) Stainbrook, 1947, p. 313, pl. 46, figs. 1, 1a.

This species is distinguished from the other two members of this genus occurring in the Percha Formation (Box Member) by its small size, squarish outline, and strong convexity. It is a very rare species.

Localities.—506, b, p; 507a, c, h, o; 509b; 527d, f; 3026a; USGS 461.

Types.—Holotype: USNM 62015b. Figured Paratypes: USNM 62015a, c, d, primary types figured in Kindle (1909). Figured Hypotype of Stainbrook (1947): M.A.S. 1599 (=USNM 155778).

Order **PENTAMERIDA** Schuchert and Cooper, 1931

Suborder **PENTAMERIDINA** Schuchert and Cooper, 1931

Superfamily **PENTAMERACEA** M'Coy, 1844

Family **PENTAMERIDAE** M'Coy, 1844

Subfamily **GYPIDULINAE** Schuchert, 1929

Genus **GYPIDULA** Hall, 1867

Gypidula bowsheri new species

Plate 13, figures 26–35; plate 14, figures 1–10

Small, longer than wide and pentagonal in outline; anterior commissure moderately sulcate; surface smooth in the posterior half but costate in the anterior parts, two or three costae on the fold and one or two in the sulcus. Flanks marked by two or three costae.

Ventral valve moderately convex in lateral profile; umbonal region narrowly rounded; anterior profile strongly rounded, sides precipitous. Fold originating at about midvalve or slightly anterior thereto, low and poorly defined, gently rounded transversely. Median and umbonal regions strongly swollen; beak moderately protuberant. Beak strongly incurved, closely approaching that of the dorsal valve.

Dorsal valve gently convex in the posterior half in lateral profile but flattened in anterior half; anterior profile broadly and slightly convex. Sulcus originating abruptly just anterior to midvalve, deepening rapidly and forming short, serrate tongue. Flanks flattened.

Measurements (in mm).—

	length	dorsal valve length	width	thickness
USNM 200823 (loc. 509j)	10.3	8.2	10.0	7.1
USNM 200824 (Holotype; loc. 526f)	9.3	8.0	9.6	6.5

Diagnosis.—Small *Gypidula*, elongate, anteriorly costate, one or two costae in the sulcus.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, i, j; 509j, n, q, s, v; 521e; 524n; 526f; USGS (Kirk) 541; 3045b.

Types.—Holotype: USNM 200824. Figured Paratype: USNM 200823.

Comparison.—*Gypidula bowsheri* n. sp. at once suggests another small *Gypidula* of the Late Devonian, *G. munda* (Calvin, 1878), known from a few specimens only. Comparison of Stainbrook's figure of the type specimen of *G. munda* indicates that it is a smaller and wider species. It is possible that the type specimen is immature and that the adult would be considerably larger. Although this is speculation, specimens from the Mount Hawk Formation at Winnifred Pass, Alberta, received through Dr. D. J. McLaren, are larger but similar to *G. munda* in most other characters. *Gypidula lotis* (Walcott, 1884) is also similar if not the same as *G. munda*. It is much wider than *G. bowsheri* and is more strongly costate.

Gypidula cornuta Fenton and Fenton

Plate 14, figures 66–73

Gypidula comis Hall and Clarke (not Owen, 1852), 1894, pl. 72, figs. 15–17, 21.

Gypidula cornuta Fenton and Fenton, 1924, p. 121, pl. 25, figs. 26–31; Belanski, 1928, p. 14, pl. 1, figs. 12–24, pl. 2, fig. 14.

This species has hitherto been known only from the basal "zonule" of the Cerro Gordo Member of the Hackberry Formation where it is rather rare. Although

the Sly Gap fauna shares elements with the Cerro Gordo Member, *Gypidula cornuta* was reported by Stevenson (1945, p. 239). The Stevenson specimen is now in the U.S. National Museum of Natural History and is better referred to *Gypidula bowsheri* n. sp.

Gypidula cornuta can now be recorded from the Independence Formation of Iowa, a formation nearly contemporaneous with the Sly Gap Formation. A specimen (USNM 200821) presented to the U.S. National Museum of Natural History by Dr. M. A. Stainbrook, is well within the range of variation of *G. cornuta*. The specimen has an elliptical dorsal valve with deep sulcus occupied by a single costa. The fold of the ventral valve is low and narrow, defined only in the front half of the valve and marked by a slight median depression corresponding to the costa in the sulcus. The beaks of both valves are closely appressed and the flanks have one obscure costa.

Measurements (in mm).—USNM 200821: length 20.8, dorsal valve length 16.5, width 21.0, thickness 15.8.

Stratigraphic occurrence.—Independence Formation.

Locality.—526t.

Types.—Figured Hypotype: USNM 200821.

***Gypidula mimica* new species**

Plate 13, figures 18–25

About medium size for genus, length and width nearly equal; outline roundly pentagonal; anterior commissure strongly sulcate. Surface of posterior half smooth, that of anterior half costate; four costae in fold and three in sulcus; flanks marked by three costae on right side and four on left when viewed from ventral side.

Ventral valve moderately convex in lateral profile, most convex in umbonal region; anterior profile strongly and roundly convex; umbonal and median region strongly swollen; fold originating 23 mm anterior to the beak (measured along the surface); fold occupying slightly less than half valve width, low and flattened, forming a moderate recess at anterior margin; flanks moderately swollen and descending steeply to margins. Ventral valve protruding 5.5 mm posterior to beak of the dorsal valve.

Dorsal valve flatly convex in lateral profile, most curved anteriorly; anterior profile broadly and gently convex; sulcus originating abruptly about 10 mm anterior to beak and producing short truncated tongue; flanks bounding sulcus flattened.

Measurements (in mm).—USNM 200820 (Holotype): length 21.0, dorsal valve length 16.4, width 22.0, thickness 14.0.

Diagnosis.—*Gypidula* with posterior half smooth, anterior part costate with strongly protuberant ventral valve.

Stratigraphic occurrence.—Sly Gap Formation (upper part).

Locality.—506c.

Types.—Holotype: USNM 200820.

Comparison.—This species is more like the Cedar Valley *Gypidula occidentalis* (Hall, 1858) than it is like *G. cornuta* Fenton and Fenton (1924) and forms related to that species. *Gypidula mimica* differs from *G. occidentalis* in having a less convex dorsal valve, less strongly costate margins, less incurved ventral beak, stronger tongue on the dorsal valve, and more strongly rounded lateral profile. *Gypidula comis* (Owen, 1852) is another similar Cedar Valley species but it is larger, with narrower, more protuberant beak, stronger costation and deeper sulcus than *G. mimica*. *Gypidula mimica* differs from *G. cornuta* Fenton and Fenton in being more costate anteriorly, less protuberant posteriorly, in having a shallower sulcus and less approximate beaks.

***Gypidula stainbrookii* new species**

Plate 14, figures 11–18

About medium size for genus, angularly pentagonal in outline; length and width nearly equal. Posterior quarter of exterior smooth, anterior three-quarters strongly costate. Costae subangular and prominent; two on the fold separated by a deep furrow; one in the sulcus and two, plus an incipient third costa, on each flank.

Ventral valve strongly convex in lateral profile, narrowly domed and having precipitous sides in anterior profile. Fold originating eight mm from beak (measured along surface); fold visible on the umbonal region, strengthened and elevated slightly anteriorly but never strongly elevated above the flanks; median region strongly inflated; flanks swollen and steep.

Dorsal valve gently convex in posterior third but flattened or slightly concave anteriorly; anterior profile nearly flat; sulcus originating seven mm anterior to beak, widening abruptly, deepening anteriorly to produce a fairly long, serrate tongue. Flanks flattened or slightly concave.

Measurements (in mm).—USNM 200822 (Holotype): length 17.1, dorsal valve length 14.3, width 18.3, thickness 12.8.

Diagnosis.—*Gypidula* resembling *G. cornuta* Fenton and Fenton (1924) but costae extending for three-fourths the valve length.

Stratigraphic occurrence.—Independence Formation.

Locality.—526t.

Types.—Holotype: USNM 200822.

Comparison.—As mentioned above, this specimen is suggestive of *G. cornuta* Fenton and Fenton (1924) but differs in the very strong costation, and in less protuberance of the ventral beak beyond the dorsal valve posterior margin.

Discussion.—This species was taken by Stainbrook from the Brandon, Iowa quarry from which the specimen of *G. cornuta*, discussed above, was found. It might be argued that *G. stainbrookii* n. sp. is a variant of *G. cornuta* but none of the specimens of that species in the National Collection exhibits such strong costation and none with strong costation is mentioned by Fenton and Fenton (1924) in their discussion of *G. cornuta*.

***Gypidula subcarinata* new species**

Plate 13, figures 10–17

About medium size for genus, rhomboidal in outline, sides narrowly rounded; anterior margin angular; apical angle 91°. Ventral valve posterior moderately protuberant. Anterior commissure narrowly sulcate. Beak incurved and closely approaching that of dorsal valve. Posterior three-quarters smooth, anterior quarter marked by narrow costae, five or six on the flanks, four on the fold, and three in the sulcus.

Ventral valve moderately convex in lateral profile, greatest convexity in umbonal region. Anterior profile subcarinate, lateral slopes gently convex and very steep. Fold originating six mm anterior to the beak as measured along the surface, low initially but fairly prominent anteriorly. Fold narrowly convex and forming a deep re-entrant.

Dorsal valve moderately convex in lateral profile but subgeniculate somewhat posterior to midvalve where the sulcus forms; anterior profile gently and broadly convex. Sulcus deep and narrow in anterior half of valve and producing a long narrow tongue. Flanks bounding sulcus gently convex.

Measurements (in mm).—USNM 200850 (Holotype): length 15.2, dorsal valve length 14.1, width 17.8, thickness 12.1, apical angle 91°.

Diagnosis.—*Gypidula* of medium size, rhomboidal outline, narrow fold and numerous narrow costae.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—521k.

Types.—Holotype: USNM 200850.

Comparison.—This species is smaller and has a less extended ventral umbonal region, as well as more numerous costae, than *G. cornuta* Fenton and Fenton (1924). It is smaller, has more narrowly rounded lateral

extremities, narrower fold and deeper sulcus, and an entirely different shape from *G. mimica* n. sp.

Genus PENTAMERELLA Hall, 1867

***Pentamerella* species**

Plate 39, figure 29

A single ventral valve of this genus was found in the Oñate Formation at the exposures in Johnson Park Canyon, locality 3023c. The single ventral valve is of about average size for the genus, wider than long with acutely pointed beak (85°). A shallow, barely perceptible sulcus originates at about midvalve. The sulcus is occupied by five rounded costae and the flanks by nine or ten.

Types.—Figured Specimen: USNM 207699.

Order RHYNCHONELLIDA Kuhn, 1949

Superfamily RHYNCHONELLACEA Gray, 1848

Family TRIGONIRHYNCHIIDAE McLaren, 1965

Genus CUPULAROSTRUM Sartenaer, 1961b

***Cupularostrum?* *stevensoni* new species**

Plate 14, figures 19–44; plate 41, figures 18–26

Small for genus, subtriangular in outline, slightly wider than long; widest slightly anterior to midvalve; anterior commissure strongly uniplicate. Posterolateral extremities forming angle of 100° to 120°. Beak small, moderately protuberant, nearly straight to suberect. Deltidial plates small, conjunct to disjunct. Foramen hypothyriddid. Surface completely costate, costae subangular to narrowly rounded, four on fold, three in sulcus, and four or five on flanks.

Pedicle valve gently but unevenly convex in lateral profile and broadly concave in anterior profile. Umbonal and median regions gently convex; sulcus wide and deep starting abruptly just posterior to midvalve and occupying half or slightly more of valve width; tongue long, serrated. Flanks narrow and flattened; anterolateral extremities strongly deflected in ventral direction.

Dorsal valve moderately and unevenly convex in lateral profile, the maximum convexity in the posterior; anterior profile rounded dome with median area slightly elevated above the convex and steeply descending flanks. Fold originating posterior to midvalve, elevating above the flanks at about midvalve.

Ventral valve interior with short stout dental plates. Dorsal valve with greatly thickened structures, the apical chamber small and narrow; hinge plate divided and median septum short and very thick. Inner margins of both valves with a row of small interlocking ridges.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	thick- ness	apical angle
USNM 200896a (Holotype; loc. 523v)	11.0	9.8	12.7	7.4	105°
USNM 200896b USNM 201029a (loc. 509u)	9.4	8.5	11.5	6.4	107°
USNM 201029b	11.2	10.0	13.0	7.4	107°
USNM 200846 (loc. 524z)	9.5	8.4	11.0	6.0	103°
	10.4	9.5	11.9	6.5	103°

Diagnosis.—Small *Cupularostrum* with four costae on the fold and greatly thickened cardinalia with divided hinge plate.

Stratigraphic occurrence.—Contadero and Rhodes Canyon formations.

Localities.—Contadero: 509t; 523q; 526g; Rhodes Canyon: 509u; 521g, j; 523p, v; 524z; 526a.

Types.—Holotype: USNM 200896a. Figured Paratypes: USNM 200896b, 201029a, b.

Discussion.—This species is most similar to *Ptychomalotoechia sobrina* (Stainbrook, 1947) from the Percha Formation (Box Member). The Percha species is larger than the Rhodes Canyon form when compared to the largest specimens of *C. ? stvensoni*. Other minor differences are in the greater reflection ventrally of the anterolateral margins of *P. sobrina*, and its slightly greater width. A more important difference appears on the inside of *P. sobrina* which has delicate cardinalia and an undivided hinge plate.

Cupularostrum saxitilis (Hall, 1867) is another species resembling *C. ? stvensoni* but that species has more costae, often with five on the fold, and less prominent anterolateral extremities.

A species of *Cupularostrum* from the Three Forks Formation of Montana, often referred to *C. contracta* (Hall, 1843), is very similar to *C. ? stvensoni* but its interior has not been described. *Cupularostrum contracta* is a larger and more numerously costate species than *C. ? stvensoni*.

***Cupularostrum*? species**
Plate 14, figures 45–49

This species, represented by a single specimen, is characterized by having its costation extending onto the beaks. It is thus different from *Hadorrhynchia McLaren* (1961), with which it occurs, because that genus has smooth umbonal regions. The specimen in question is small, with a flattened dorsal valve having a broad serrated re-entrant to receive the short tongue of the ventral valve. Five strong rounded costae occupy the sulcus and six occur on the fold. The sulcus begins near midvalve but is shallow and broad. The flanks are marked by four broadly rounded costae.

Measurements (in mm).—USNM 200895: length 12.8, dorsal valve length 11.4, width 13.4, thickness 8.8, apical angle 111°.

Diagnosis.—Completely costate rhynchonellid having six costae on the fold and five in the sulcus.

Stratigraphic occurrence.—Oñate Formation.

Locality.—523d.

Types.—Figured Specimen: USNM 200895.

Discussion.—This specimen is placed questionably in *Cupularostrum* because of its completely costate shell, long median septum in the dorsal valve, and presence of dental plates. Its nearest relatives seem to be undescribed species from the Middle Devonian Hamilton Group of New York.

Genus *PTYCHOMALOTOECHIA* Sartenaer, 1961a

***Ptychomalotoechia sobrina* (Stainbrook)**

Plate 41, figures 8–17

Camarotoechia contracta Kindle (not Hall, 1843), 1909, p. 22, pl. 6, figs. 1–2a.

Camarotoechia sobrina Stainbrook, 1947, p. 314, pl. 47, figs. 19–22.

Serial sections indicate that this species belongs to *Ptychomalotoechia*. It is a very abundant species and is found at most exposures of the Percha Formation (Box Member).

Localities.—506, a, b, p, q; 507a, c, d, f, h, k, l, m, n, o, t, u, y; 509a, b, c, e; 527c, d, e, f, g, h, l; 3026, a; 3029; 3030; 3031b; 3042, s.

Types.—Holotype: M.A.S. 1594 (=USNM 135244). Figured Paratypes: M.A.S. 1594a–c (=USNM 135245a–c). *Camarotoechia contracta* Kindle (not Hall, 1843), USNM 62018a–c.

Genus *ATHABASCHIA* Crickmay, 1963

***Athabascia*? species 1**

Plate 14, figures 50–57; plate 16, figures 7–11

Small, widely pentagonal in outline; maximum width at about midvalve; sides rounded and anterior margin truncated. Apical angle broadly obtuse; beak small, protuberant. Fold and sulcus wide, originating in anterior third; margins costate, costae subangular, three on fold, two in sulcus and four on flanks. Dental plates and median septum short.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	thick- ness	apical angle
USNM 200914a (loc. 509f)	10.0	8.9	12.8	7.0	128°
USNM 203525 (loc. 524u)	13.3	11.7	16.4	7.6	123°

Diagnosis.—Widely pentagonal *Athabascia*? with two costae in the sulcus.

Stratigraphic occurrence.—Sly Gap Formation (*Thomasaria* Zone).

Locality.—509f; 524u.

Types.—Figured Specimens: USNM 200914a, 203525.

Discussion.—This species suggests “*Pugnoides*” *solon* Thomas and Stainbrook (1922) but is smaller, has a proportionally narrower sulcus and fold and more strongly geniculated tongue on the ventral valve. It differs from *Athabascia*? sp. 2 in its smaller size, narrower outline and more strongly developed antero-lateral extremities bounding the sulcus.

Athabascia? species 2

Plate 21, figures 32–37

Two other specimens are referred questionably to this genus. Both have a long median septum and both have the characteristic exterior: broadly elliptical, smooth posterior half, costate anterior with three costae on fold and two in sulcus. These specimens have stronger and more rounded costae than the other two lots referred to *Athabascia*? species 1.

Stratigraphic occurrence.—Thoroughgood Formation.

Locality.—522.

Types.—Figured Specimens: USNM 201041a, b.

Genus **RIPIDIORHYNCHUS** Sartenaer, 1966b

Ripidiorhynchus newmexicoense new species

Plate 15, figures 1–20; plate 41, figures 34–40

Large, broadly subtriangular in outline; wider than long; maximum width slightly anterior to midvalve. Anterior commissure strongly uniplicate. Sides narrowly rounded; anterior margin truncated, posterolateral margins forming an angle of 100° to 120°. Beak small, suberect; foramen small, deltidial plates small, questionably disjunct. Surface completely costate, costae strong, usually four on fold, although a costa may be emplaced on one or both lateral slopes of fold, usually three in sulcus and five or six on flanks, which are not always symmetrical, one flank having six costae, the other only five.

Ventral valve in lateral profile slightly convex in posterior half or less, becoming strongly geniculated anteriorly; anterior profile fairly deeply concave, anterolateral extremities strongly protuberant and bounding curve. Sulcus originating suddenly at midvalve, deepening rapidly and occupying about 60 percent of maximum width. Flanks narrow, slightly convex and having a gentle slope to the margins. Tongue long, anteriorly serrate, slightly rounded and nearly flat.

Dorsal valve moderately convex in lateral profile, most so in posterior part; anterior profile strongly semielliptical, slightly elevated medially by fold. Umbonal median region and flanks swollen. Fold originating slightly posterior to midvalve, moderately elevated above flanks at anterior.

Ventral valve interior having fairly long divergent dental plates. Dorsal valve with delicate cardinalia, hinge plate undivided, outer hinge plates fairly wide, inner hinge plates joined and forming a low arch over the apical chamber; socket ridges high and thin. Median septum thin and long, extending about to midvalve.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	thick- ness	apical angle
USNM 200920a (Holotype; loc. 509t)	15.5	14.2	17.8	11.6	110°
USNM 200920b	15.8	14.7	17.8	11.1	110°
USNM 200920c	17.4	16.3	21.0	13.2	111°
USNM 200892 (loc. 526g)	17.6	16.2	20.3	13.4	115°

Diagnosis.—Large, strongly costate *Ripidiorhynchus* having the length 85 to 90 percent of the width.

Stratigraphic occurrence.—Contadero Formation; Rhodes Canyon Formation.

Localities.—509t, u; 521j; 522a; 524t; 526g; 528a; 3054k.

Types.—Holotype: USNM 200920a. Figured Paratypes: USNM 200892, 200920e, 204952. Unfigured Paratypes: USNM 200920b–d.

Discussion.—The nearest species to this one is *Ripidiorhynchus orbicularis* (Hall, 1860a) from the Chemung Formation of New York. Although the two species are similarly marked, that from New York and Pennsylvania is rounder, has a wider fold and sulcus, and less extended or reflected anterolateral extremities.

MORPHORHYNCHUS new genus

[Gr. *Morpho* = the shapely one]

About medium-sized for a rhynchonellid, subrectangular in outline; anterior commissure broadly uniplicate; umbones smooth; ventral beak small, not protruding and closely pressed to the dorsal umbo; foramen small; deltidial plates small, disjunct. Surface costate, costae strong and subangular, dying at umbones.

Ventral valve interior with fairly long, closely spaced dental plates and small teeth. Other features not visible. Dorsal valve interior with long median septum supporting a short, narrow septalium covered by a moderately long inner hinge plate that is perforate at the rear. Socket ridges slender.

Type species.—*Morphorhynchus varicostatum* n. sp.

Diagnosis.—Medium-sized rhynchonellid having subrectangular outline, smooth umbones, costate shell uniplicate with closely-spaced dental plates and small, narrow septalium partially covered by a posteriorly perforate inner hinge plate.

Comparison.—The form and construction of the hinge plate suggest relationship to *Cupularostrum* Sartenauer (1961b) and, in external form, to *Hadorrhynchia* McLaren (1961). It differs from the former in its rectangular form, very wide fold and sulcus, and the different interior. *Cupularostrum* is described as having a convex inner hinge plate but this is quite unlike the inner hinge plate of *Morphorhynchus*, which is flat. Furthermore, the crura of *Morphorhynchus* splay horizontally while those of *Cupularostrum* are flattened laterally.

The interior of *Hadorrhynchia* is entirely different from that of *Morphorhynchus* because its septalium is filled with limy tissue rather than being covered by an inner plate (McLaren, 1962, fig. 16, p. 60).

***Morphorhynchus varicostatum* new species**

Plate 15, figures 21–28; plate 41, figures 41–49

Medium sized, subrectangular in outline; wider than long, length equal to slightly more than 80 percent of the width; widest at midvalve. Sides narrowly rounded; anterior truncated; posterolateral margins forming an angle of 120° to 140°. Beak small, closely pressed onto dorsal umbo; foramen small, deltidial plates small, disjunct. Anterior commissure broadly uniplicate. Surface costate, costae thick and subangular, two or usually three in sulcus and three, but more often, four on fold. Micro-ornament mostly worn off but occasional patches of closely spaced concentric lines are preserved. Beaks of both valves smooth. Flanks marked by four or five costae.

Ventral valve gently convex in the posterior half but strongly geniculated in dorsal direction in anterior half; anterior profile broadly concave, anterolateral extremities strongly protuberant. Sulcus broad and deep, originating at about midvalve and forming a long, gently rounded and serrate tongue. Sulcus usually occupied by three costae, the median one of which is stronger than the lateral ones. Sulcus occupying about 60 percent of the valve width. Flanks narrow, flattened, or slightly concave.

Dorsal valve unevenly convex in lateral profile, the posterior part gently convex, the anterior flattened; anterior profile narrow, rounded dome with steep sides. Fold originating slightly posterior to midvalve, elevating and widening anteriorly where it stands above the narrow, convex flanks.

Ventral valve interior with narrowly divergent, closely spaced dental plates. Dorsal valve with undivided hinge plate, small apical chamber and unusually long median septum extending nearly half valve length. Crura long, curved, expanding and flattening distally.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	thick- ness	apical angle
USNM 200922a (Holotype; loc. 522f)	13.5	21.8	15.8	9.8	137°
USNM 200922b	10.7	10.1	13.5	7.8	127°
USNM 201173 (loc. 523i)	12.4	11.8	14.3	11.7	122°
USNM 200919a (loc. 506d)	14.3	13.0	17.3	11.4	126°

Diagnosis.—Medium-sized transversely subrectangular *Morphorhynchus* with four costae on the fold.

Stratigraphic occurrence.—Oñate Formation.

Localities.—506d; 522f, g, l; 523e, i.

Types.—Holotype: USNM 200922a. Unfigured Paratypes: USNM 200919a, b; 200922b, c; 201173.

Discussion.—This species is much smaller than *Hadorrhynchia mclareni* n. sp., and is also smaller and differently shaped than *Hadorrhynchia alta* n. sp., both from the Oñate Formation. It is most like *Hadorrhynchia eurekaensis* Johnson (1966), considered a *Cassidirostrum* by Johnson (written commun., 1981), from the Middle Devonian (Denay Limestone) of Nevada. It differs in having stronger costae in the fold and sulcus, although the number of costae is the same, in the more lateral sweep to the costae on the flanks and in the smaller, less protuberant beak.

Family **UNCINULIDAE** Rzhonsnitskaya, 1956

Subfamily **HYPOTHYRIDININAE**
Rzhonsnitskaya, 1956

Genus **HYPOTHYRIDINA** Buckman, 1906

***Hypothyridina emmonsii rotunda* new subspecies**
Plate 15, figures 39–56; plate 16, figures 1–6;
plate 39, figures 8–17

Hypothyridina sp. B. McLaren and Norris, 1962, p. 30, pl. 14, figs. 7–9.

About medium-sized for genus, subcircular in outline; length varying from 0.84 to 1.12 of the width; sides broadly rounded, anterior truncated and posterolateral extremities forming broadly obtuse angle. Maximum width at midvalve. Anterior commissure strongly uniplicate, the tongue of the ventral valve occupying about two-thirds valve width. Beak small and incurved, often pressed closely to the dorsal valve umbo. Surface marked by flatly rounded costae, ten

to 14 on the fold, nine to 13 on the sulcus, and up to 21 on the flanks.

Ventral valve gently convex in lateral view and broadly concave in anterior view, the median part flattened but the flanks strongly deflected in ventral direction. Median region swollen; sulcus wide, shallow, and defined anteriorly by the strongly deflected an-

terolateral extremities; tongue long, strongly geniculated, and broadly rounded anteriorly.

Dorsal valve very deep, gently convex in lateral profile, the surface sloping as the valve thickens anteriorly; anterior profile high, rounded dome with nearly straight sides; flanks gently convex and slightly folded medially at the anterolateral extremities.

Measurements (in mm).—

	length (L)	dorsal valve length	width (W)	thickness	fold width	costellae on tongue	L/W ratio
USNM 200947b (Holotype; loc. 506v)	21.0	19.7	21.8	17.6	15.0	10	0.96
USNM 200950a (loc. 509g)	23.4	21.4	25.5	19.1	16.6	11	0.92
USNM 200950c (loc. 509g)	19.8	18.4	21.4	10.6	12.3	10	0.92
USNM 201160c (loc. 509h)	14.0	13.0	12.5	11.2	8.5	7	1.12
USNM 201172 (loc. 509m)	26.9	25.0	26.0	23.6	18.2	13	1.07
USNM 201171b (loc. 521d)	14.4	13.6	15.5	12.3	10.2	9	0.93
USNM 200946 (loc. 521e)	24.1	22.5	28.2	21.0?	20.0	12	0.85
USNM 200948b (loc. 506c)	20.0	18.0	22.0	17.1	10.7	9	0.91
USNM 203499a (loc. 506c)	16.3	14.7	16.0	13.0	11.9	11	1.02
USNM 203499b (loc. 506c)	15.2	14.6	15.5	13.1	13.0	14	0.98
USNM 203496 (loc. 506i)	22.9	21.5	24.6	19.7	19.1	12	0.93
USNM 201161a (loc. 506j)	14.6	13.7	15.8	12.8	8.7	8	0.92
USNM 14023a Holotype of <i>Hypothyridina emmonsii</i> (Hall and Whitfield)	23.1	21.6	26.4	20.6	17.0	13	0.87

Diagnosis.—Like *Hypothyridina emmonsii* (Hall and Whitfield, 1877), but less transverse than the typical subspecies.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, i, j, v; 509f, g, h, i, m, n, s, w, z; 521c, d, e, k, m, n, p, r, u; 524m, w; 526k.

Types.—Holotype: USNM 200947b. Figured Paratypes: USNM 200946, 200947c, 200948b, 200949a, 200950c, 201160a, 201162. Unfigured Paratypes: all listed Measured Specimens.

Discussion.—*Hypothyridina* is fairly common in the upper part of the Sly Gap Formation in the Sacramento Mountains, but it is less abundant in the San Andres Range. In many places, two size grades of specimens occur, one that ranges up to about 15 mm long and another that is larger. The size range suggests a second species but the small ones have the same proportions as the larger ones and are probably specimens that reached adulthood before they attained the more nor-

mal larger size. All of the specimens are here regarded as a single subspecies.

Compared to the type specimen of *H. emmonsii*, the New Mexico specimens have the same proportions of thickness to width and of width of fold to width, but when the length/width ratio is compared the New Mexico specimens are nearly all less transverse than the Nevada specimen. The mean length/width ratio suggests a more nearly circular shell—that is, length approximately equals width—than the Nevada species, which is visibly transverse. Unfortunately, only one good specimen is known from Nevada and, consequently, its variation is unknown.

Hypothyridina species

Plate 15, figures 29–38; plate 23, figures 1–6

About medium-sized for genus, rectangularly subquadrate in outline; sides moderately rounded; anterior truncated. Anterior commissure strongly unipli-

cate. Surface marked by fairly broad costae, about 12 on the flanks, eight in the sulcus, and nine on the fold.

Ventral valve with posterior half moderately swollen, swollen area separated from the lateral parts by gently concave areas; anterior profile broadly concave but with median part slightly convex. Posterolateral extremities not prominent. Sulcus forming about 65 percent of the midwidth.

Dorsal valve fairly strongly convex in posterior half, anterior half flattened; anterior profile narrow, steep-sided dome; flanks gently inflated; median region strongly swollen.

Measurements (in mm).—USNM 201090a: length (L) 18.7?, dorsal valve length 17.3?, maximum width (W) 21.4, thickness (T) 15.8, width of fold (F) 12.2, L/W ratio = 0.88, T/W ratio = 0.73, F/W ratio = 0.57.

Diagnosis.—Medium-sized, somewhat transverse *Hypothyridina* having strong crowded costae of which eight occupy the tongue of the ventral valve.

Stratigraphic occurrence.—Oñate Formation.

Localities.—506d; 509p; 522n; 523d; 524r; 526b, c; 528s.

Types.—Figured Specimens: USNM 201090a, b; 201141.

Discussion.—A few poor specimens of *Hypothyridina* from the Oñate Formation are reminiscent of *H. venustula* (Hall, 1867) or *H. procuboides* (Kayser, 1871), both from the Givetian. The costation of *Hypothyridina cameroni* Warren (1944) has some resemblance to the Oñate form, but it is larger, wider, and has more flaring lateral extremities. Specimen USNM 201141 appears to be an immature specimen of this Oñate species of *Hypothyridina*.

Subfamily HADRORHYNCHIIINAE McLaren, 1965

Genus HADRORHYNCHIA McLaren, 1961

Hadrorhynchia alta new species

Plate 16, figures 12–31; plate 18, figures 8–17

Small for genus, narrowly pentagonal in outline; length and width nearly equal; sides broadly rounded, anterior margin truncated; posterolateral extremities forming an angle of 98° to 118°. Anterior commissure strongly uniplicate; beak low, incurved, suberect. Deltidial plates disjunct. Posterior smooth, noncostate but marked by fine, flattened radial lines. Anterior marked by strong angular costae, three or four on fold with one less in sulcus, and usually three, occasionally four, on lateral extremities.

Ventral valve convex in posterior half in lateral profile but strongly geniculated anteriorly; anterior profile

deeply concave, flanks swept up into narrow points. Umbonal region narrowly swollen, swelling extending onto anterior before inception of sulcus; umbolateral slopes short and rounded. Sulcus beginning at midvalve, deepening rapidly and occupying three-fifths the shell width. Tongue long, geniculated and flattened anteriorly, the costae and interspaces having narrow, flattened longitudinal bands.

Dorsal valve deep, moderately convex in lateral profile but narrowly domed in anterior profile with fold protruding beyond the rounded, precipitous flanks. Fold originating at midvalve, narrow, strongly elevated above flanks at anterior. Anterior margin geniculated to meet that of ventral valve. Troughs between costae extended anteriorly and laterally as flattened bands to meet troughs and ridges of opposite valve.

Measurements (in mm).—

	length	dorsal valve length	width	thick- ness	apical angle
USNM 201139a (loc. 523b)	18.8	16.4	20.1	15.5	115°
USNM 201139b	16.9	15.1	18.2	10.2	108°
USNM 201140b (Holotype; loc. 523d)	19.8	17.0	20.0	13.3	101°
USNM 201140a	19.6	17.1	20.7	15.0	118°
USNM 201140d	16.3	14.3	18.0	12.0	115°
USNM 201140e	12.6	11.5	13.5	5.5	108°

Diagnosis.—Small *Hadrorhynchia* having a narrow fold, and acute anterolateral extremities that are extended strongly in a ventral direction.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522f, 523a, b, d, e, f, h, i; 3025c.

Types.—Holotype: USNM 201140b. Figured Paratypes: USNM 200898a, b; 201139a; 201140a; 203526. Unfigured Paratypes: USNM 201139b; 201140c–e.

Discussion.—Compared to *Hadrorhynchia sandersoni* (Warren, 1944), in the length range of 18 to 22 mm, the specimens from New Mexico prove to have nearly equal length and width (mean L/W ratio = 0.94). McLaren's specimens have a mean T/L ratio = 1.14 whereas the same ratio for *H. alta* n. sp. is 1.06. The mean W/L ratio of *H. sandersoni* in this size range is 0.78 but that of *H. alta* is 0.72. Compared to *H. mclareni* n. sp., *H. alta* does not attain the large size of the former, has more strongly deflected anterolateral extremities, fewer costae on the flanks, and a narrower fold.

This species, like its relative *H. mclareni*, is restricted to the shaly facies of the Oñate Formation, but it has not been found outside of the Caballos Mountains and Derry Hills.

***Hadrorthynchia mclareni* new species**

Plate 17, figures 20–43

Medium-sized for genus, subpentagonal to broadly oval in outline; valves unequal in depth and convexity, dorsal valve having greater dimensions in both; sides rounded, anterior truncated, posterolateral extremities forming angle of 118° to 128°. Beak small, incurved; beak ridges sharp, defining small, curved interareas. Deltidial plates disjunct. Anterior commissure strongly uniplicate. Fold having four or five costae, the flanks five or six. Anterior surface plicate, posterior without plication but whole surface covered by fine, flat, radiating capillae and crossed by fine concentric threads. Costae in sulcus bearing a median flat groove.

Ventral valve gently convex in lateral profile, the posterior half flatly convex but the anterior strongly curved to geniculate; anterior profile flatly to strongly concave; umbonal region slightly swollen; posterolateral areas rounded and sloping steeply to posterior

margins; sulcus originating abruptly at about mid-valve, wide and deep, occupying slightly more than half valve width. Flanks bounding sulcus variable from flattened and slightly flaring to strongly elevated. Tongue long and anteriorly geniculated in the adult.

Dorsal valve unevenly convex in lateral profile, anterior part gently convex but umbonal region moderately curved. Anterior profile forming strong dome having steeply sloping sides, becoming abruptly vertical at place of geniculation in adults. Median region strongly swollen; flanks fairly strongly swollen. Fold forming only at the anterior and extending a variable distance posteriorly but usually not extending beyond midvalve. Anterior margin geniculated in the adult.

Dorsal valve interior with broad, concave outer hinge plates and elevated socket ridges; crura long, flattened, distally expanded and concave in an anterior direction.

Measurements (in mm).—

	length (L)	dorsal valve length	maximum width (W)	thickness (T)	apical angle	L/W ratio
USNM 200897b (loc. 523b)	14.0	13.0	16.4	7.2	120°	0.85
USNM 200897a (loc. 523b)	25.0+	24.0	31.5	18.5	127°	0.84
USNM 200891a (Holotype; loc. 523d)	26.0	23.8	29.0	16.5	123°	0.90
USNM 200891b (loc. 523d)	22.7	20.3	27.0	18.5	122°	0.83
USNM 200891c (loc. 523d)	25.0?	23.0	29.8	18.0	125°	0.85?
USNM 200891d (loc. 523d)	24.8	21.3	25.7	18.0	118°	0.97
USNM 203500 (loc. 523k)	25.4?	24.0	31.4	16.4	128°	0.90
USNM 203501a (loc. 523b)	23.5	21.4	27.8	15.0	119°	0.85
USNM 203501b (loc. 523b)	21.5	19.6	25.5	12.5	125°	0.84
USNM 203502a (loc. 523f)	23.0?	21.2	25.0	20.0	118°	0.88
USNM 203502b (loc. 523f)	11.7	10.5	12.3	5.0	106°	0.87

Mean T/W ratio = 0.65; Mean L/W ratio = 0.87; Mean W/L ratio = 1.07.

Diagnosis.—*Hadrorthynchia* of medium size and moderate thickness.

Stratigraphic occurrence.—Oñate Formation.

Localities.—523b, d, f, h, k.

Types.—Holotype: USNM 200891a. Figured Paratypes: USNM 200891d, e, g; 200897a, b; 200903; 200918. Unfigured Paratypes: USNM 200891b, c, f; 200892a; 203500; 203501a, b; 203502a, b.

Discussion.—This species is very close to *H. sandersoni*

(Warren, 1944) but that species has a much thicker and generally rounder shell than the New Mexico form. McLaren (1962, p. 62) gives the mean T/L ratio for *H. sandersoni* as 0.94 and the mean W/L ratio as 1.07 for specimens 22 mm or more in length. The same proportions of *H. mclareni* of this size group are: mean T/L ratio = 0.65 and mean W/L ratio = 0.87. A specimen from the Beavertail Limestone on McKenzie River attains larger dimensions than any specimen from

New Mexico, and is also larger than any listed by McLaren, but its proportions are in accordance with those cited by McLaren.

Hadrorthynchia mclareni is an uncommon species and, so far as we now know, it is restricted to the shaly facies of the Oñate Formation in Mud Springs Mountains, the Derry Hills and Caballos Mountains.

Family **PUGNACIDAE** Rzhonsnitskaya, 1956

Genus **COELOTERORHYNCHUS** Sartenaer, 1966a

Coeloterorhynchus magnificum new species

Plate 17, figures 4–19; plate 18, figures 31–57;
plate 40, figures 1–10

Pugnoides schucherti Stainbrook, 1948, p. 774, pl. 2, figs. 34, 35, 37.

Large for genus, rounded pentagonal in outline, wider than long; maximum width at or near midvalve; sides strongly rounded; anterior margin truncated; posterolateral margins forming angle of approximately 120°. Anterior commissure strongly uniplicate. Valves very unequal in depth, the ventral valve shallow, the dorsal valve deep. Beak small, incurved, erect; foramen small, often bisecting the beak; deltidial plates disjunct. Posterior two-thirds smooth, margins variably costate, flanks having four or five costae, fold two to five, usually three or four, and sulcus one to four.

Ventral valve fairly strongly convex medially but broadly concave in anterior profile and having the anterolateral extremities swept up in a ventral direction. Median region flatly convex, posterolateral slopes short and convex; sulcus wide, originating slightly posterior to midvalve, deepening anteriorly, and occupying about 0.7 the valve width; tongue long and strongly bent in a dorsal direction, its end strongly serrate and narrowly rounded. Flanks steeply dipping toward middle of valve.

Dorsal valve unevenly convex in lateral profile, posterior half moderately convex but anterior half flattened; anterior profile almost hemispherical, sides sloping strongly, and flanks gently convex. Fold forming at about midvalve usually narrow, occupying about half valve width; fold variable, usually with the one or two median costae elevated above the others, which appear on the slope of fold. Anterolateral extremities strongly directed ventrally.

Measurements (in mm).—

	dorsal length (L)	valve length	maxi- mum width (W)	thick- ness	apical angle	L/W ratio
USNM 200915a (loc. 506c)	10.9	9.7	11.8	5.3	107°	0.93

	dorsal length (L)	valve length	maxi- mum width (W)	thick- ness	apical angle	L/W ratio
USNM 200915b (loc. 506c)	12.0	11.1	13.2	6.0	111°	0.91
USNM 200915c (loc. 506c)	13.4	12.0	16.0	6.6	112°	0.84
USNM 200915d (loc. 506c)	14.4	12.1	15.1	8.7	123°	0.95
USNM 200915e (loc. 506c)	16.4	15.0	16.8	9.6	122°	0.98
USNM 200915f (loc. 506c)	16.9	15.5	17.7	10.8	121°	0.96
USNM 200915g (loc. 506c)	18.5	17.0	19.5	12.4	125°	0.95
USNM 200915h (loc. 506c)	19.5	17.8	20.1	12.1	122°	0.97
USNM 200915i (loc. 506c)	16.4	15.0	18.7	10.8	120°	0.87
USNM 200915j (loc. 506c)	20.9	19.2	21.4	13.0	125°	0.98
USNM 200915k (loc. 506c)	21.1	19.4	25.2	14.0	123°	0.85
USNM 200915l (Holotype)	22.6	20.2	25.6	14.8	124°	0.88
USNM 200913 (loc. 506c)	20.4	18.3	20.7	14.8	114°	0.99
USNM 200912 (loc. 521p)	21.0	19.6	24.7	13.3	125°	0.85
USNM 200828c (loc. 526k)	20.8	18.8	22.8	15.0	133°	0.91
USNM 200828a (loc. 526k)	22.8	21.0	24.6	15.0	130°	0.93
USNM 200828b (loc. 526k)	21.9	20.3	25.7	13.0	126°	0.85

Diagnosis.—Large, nearly circular to slightly transverse *Coeloterorhynchus* with moderate thickness.

Stratigraphic occurrence.—Sly Gap Formation; Contadero Formation.

Localities.—Sly Gap: 506c, i, j, v, y; 509f, g, h, ha, i, j, m, n, o, p, q, s, v, w; 521c, e, k, l, m, o, p, r; 524m, v; 526k, l, x; 529s, x; USGS (Kirk) 541; 543. Contadero: 521h.

Types.—Holotype: USNM 200915l. Figured Paratypes: USNM 200915b, c, g, i, k; 200912; 200913; 200916; 200917a. Unfigured Paratypes: all Measured Specimens.

Discussion.—The young of this species are nearly circular as they have length and width nearly equal and the L/W ratio usually equals 0.90 or more. The species attains a large size, the largest species of the genus so far found in this country. In this regard, it differs strongly from *Coeloterorhynchus calvini* (Fenton and Fenton, 1924) from the Cerro Gordo Member of the Hackberry Formation, which is small and has an exaggerated depth dimension. The fold of *C. calvini* is strongly angular and the marginal costae are strong-

ly angular. *Coeloterorhynchus magnificum* n. sp. also attains a larger size than *C. schucherti* (Stainbrook, 1945) from the Independence Formation of Iowa. The Independence species is quite variable and has a L/W ratio like that of *C. magnificum* but its T/W ratio is much greater and indicates a shell with exaggerated depth like that of *C. calvini*. Comparison of Independence species is usually difficult because of the rare and spasmodic outcrops and general unavailability of collections. The ten specimens of *C. schucherti* in the National Collections are mostly small and the largest one is smaller and much differently shaped than *C. magnificum*; *C. schucherti* is much more like *C. calvini* and is probably related to that species rather than to the one from New Mexico.

Coeloterorhynchus magnificum n. sp. is fairly common in the Sly Gap Formation of the Sacramento Mountain Range, but it is less common in the San Andres Range and is very rare west of there. The species is variable in the degree of costation, the angularity of the fold and, to some extent, in its dimensions.

Coeloterorhynchus species

Plate 14, figures 58–65

Small, pentagonal in outline, pugnacid in appearance with posterior regions smooth and anterior margins strongly costate; length and width about equal; apical angle nearly 90°; sides bulging; anterior margin truncated. Anterior commissure strongly uniplicate. Beak small, moderately protuberant. Anterolateral extremities bounding the sulcus projecting strongly. Costae narrowly subangular, three on the fold, two in the sulcus, and four on the flanks.

Ventral valve gently convex in posterior half, geniculated in a dorsal direction in anterior half; anterior profile gently concave; sulcus originating at anterior third, narrow, occupying slightly less than half width. Dorsal valve nearly flat in lateral profile but narrowly domed in anterior view. Fold short, originating at about two-thirds valve length from the beak. Flanks moderately swollen.

Ventral valve interior with dental plates and dorsal valve having a short median septum.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	thick- ness	apical angle
USNM 200894 (loc. 509f)	12.1	10.5	11.8	8.6	104°

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—509f; 522k.

Types.—Figured Specimen: USNM 200894.

Discussion.—This species is suggestive of some forms of “*Pugnoides*” *alta* Williams (1890) from the State Quarry Formation of Iowa, but it differs in its narrower fold, greater proportional width and sharper costae. The species is very rare.

COLOPHRAGMA new genus

[Gr. *kolos*, shortened; *phragma*, fence (septum)]

Medium-sized rhynchonellid, transversely elliptical to transversely pentagonal in outline; biconvex, the dorsal valve having the greater convexity and depth; anterior commissure strongly uniplicate. Beak small, closely pressed onto the dorsal umbo; deltidial plates conjunct; foramen small, mesothyridid. Surface semicostate, costae strong and subangular.

Ventral valve interior with long dental plates defining a deep delthyrial cavity.

Dorsal valve interior having a short median septum supporting a small, short septalium; outer hinge plates broad and flattened, nearly meeting medially; crural bases thick. Other details lacking.

Type species.—*Colophragma ellipticum* n. sp.

Diagnosis.—Rhynchonellacea having the exterior of pugnacids, with an aborted median septum and broad outer hinge plates.

Comparison and discussion.—This genus has the exterior of *Athabascia* Crickmay (1963), *Coeloterorhynchus* Sartenaer (1966a), *Ningbingella* Roberts (1971), *Shumardella* Weller (1910), and *Parapugnax* Schmidt (1964). It differs from all of these, except *Coeloterorhynchus*, in the brevity of its median septum. From *Coeloterorhynchus*, it differs in the presence of a short median septum, a feature lacking in that genus.

Colophragma is like *Chapinella* Savage, Eberlein, and Churkin (1978) in external appearance but differs in internal details. *Chapinella* has no median septum and the hinge plate is divided. In *Colophragma* the hinge plate is undivided and there is a short median septum.

Colophragma ellipticum new species

Plate 16, figures 49–58; plate 17, figures 1–3;
plate 18, figures 3–7; plate 40, figures 11–19

About medium size for genus, broadly triangular in outline; wider than long; sides narrowly rounded; anterior margin broadly and gently rounded; posterolateral margins forming angle of 110°–120°. Anterior commissure strongly uniplicate. Beak small, suberect to erect. Surface paucicostate, the posterior half smooth, the anterior half costate; two costae in sulcus, three on fold, and two indistinct ones on flanks.

Ventral valve in lateral profile gently convex at the posterior, but bent near midvalve into a broad curve

to form a long, sharply serrated tongue. Anterior profile broadly concave and having strongly projecting anterolateral extremities. Sulcus beginning abruptly at midvalve, deep, and forming about 60 percent of the midwidth. Flanks narrow and flat.

Dorsal valve gently convex in lateral profile, most convex in the umbonal region. Anterior a broad and high dome having steep sides. Fold originating at about midvalve just slightly posterior of the initiation of the three costae forming it. Fold moderately elevated above narrow but inflated flanks.

Ventral valve interior with widely divergent dental plates. Dorsal valve with short median septum.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	thick- ness	apical angle
USNM 200921 (Holotype; loc. 521o)	15.2	14.0	18.2	12.5	116°
USNM 200953 (loc. 524o)	13.8	12.7	17.6	12.0	118°
USNM 203537 (loc. 528b)	13.7	12.7	17.5+	9.7	120°

Diagnosis.—Broadly elliptical *Colophragma* having two costae in the sulcus and two on the flanks.

Stratigraphic occurrence.—Contadero Formation.

Localities.—523q; 524o; 528b.

Types.—Holotype: USNM 200921. Figured Paratypes: USNM 200953; 203537.

Discussion.—This species somewhat resembles some forms of *Coeloterorhynchus magnificum* n. sp., but it differs in being wider, with shallower sulcus, and never with the fold so far extended as in *C. magnificum* n. sp. Resemblance to *Petasmaria* n. gen. is also shown in the wide outline, but that genus usually has a deeper sulcus and the median septum is long and prominent. The interior details will also serve to distinguish this species from specimens of *Athabascia* Crickmay (1963), which have a strong external resemblance.

Colophragma species 1

A specimen of *Colophragma* occurs with *Colophragma ellipticum* n. sp., from the Contadero Formation. Compared with specimens of *C. ellipticum* it is much larger, has more convex flanks, a more convex ventral valve, lower ventral beak, and a more rounded dorsal fold with four costae and a poor development of costae on the flanks.

Measurements (in mm).—USNM 203503: length 18.6, brachial valve length 16.5, maximum width 20.3, thickness 15.0.

Locality.—524o.

Types.—Mentioned Specimen: USNM 203503.

Colophragma species 2

Plate 18, figures 1, 2

About medium size for genus, transversely elliptical in outline, sides rounded; maximum width at about midvalve. Ventral valve flatly convex and having a wide sulcus occupying nearly three-fourths the valve width. Sulcus occupied by three costae that originate at about midvalve. Dorsal valve moderately convex, much deeper than the ventral valve and having the fold originating at about midvalve. Fold moderately elevated at the anterior and marked by four narrowly rounded costae. Posterior half of both valves smooth, flanks with two costae at the margin.

Ventral valve interior having short, nearly obsolete dental plates. Dorsal valve with a very short median septum.

Measurements (in mm).—USNM 200952: length 14.7, dorsal valve length 14.1, maximum width 21.0, thickness 10.8, apical angle 123°.

Stratigraphic occurrence.—Thoroughgood Formation.

Locality.—522.

Types.—Figured Specimen: USNM 200952.

Genus *TRIFIDOROSTELLUM* Sartenauer, 1961a

Trifidorostellum obscurum new species

Plate 16, figures 32–48; plate 40, figures 28–31

About medium size, roundly elliptical in outline, wider than long; strongly inequivalve, dorsal valve having greater depth than ventral one. Sides narrowly rounded; anterior margin broadly rounded. Apical angle 125° to 135°. Anterior commissure strongly uniplicate. Beak small, not prominent, closely pressed onto the dorsal umbo. Valves costate, costae narrowly rounded, not reaching the beaks, usually three on flanks, two in sulcus and three on fold.

Ventral valve moderately convex in lateral profile, medially deeply concave in anterior profile; flanks bounding sulcus narrow, gently convex and with steep slopes to the posterolateral extremities. Sulcus originating about one-fourth the length from the beak (about five mm measured on the surface) deepening rapidly and forming a long narrow tongue.

Dorsal valve strongly convex in lateral profile but highly domed in anterior profile, the fold standing strongly above the narrow, convex flanks. Fold beginning just anterior to the umbo, narrow, becoming strongly elevated anteriorly and forming deep re-entrant anteriorly.

Ventral interior with short, delicate dental plates. Hinge plate divided; no median septum.

Measurements (in mm).—

	length	dorsal valve length	width	thick- ness	apical angle
USNM 200980 (loc. 507o)	12.8	12.4	16.3	14.1	136°
USNM 200981 (Holotype; loc. 3029)	11.6	11.6	15.6	11.1	128°
USNM 201154 (loc. 3042s)	10.6	9.6	12.3	10.7	127°
USNM 203504 (loc. 506b)	11.0?	11.0	15.4	11.2	135°
USNM 203505 (Kirk loc. 512)	13.1	11.0	17.3	15.6	127°

Diagnosis.—Small, rotund *Trifidorostellum* having two costae in the sulcus and three on the flanks.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506b, p, q; 507a, n, o; 527e; 3029; 3042s; USGS 512.

Types.—Holotype: USNM 200981. Figured Paratypes: USNM 200980; 201154. Unfigured Paratypes: USNM 203504; 203505.

Comparison.—This is the smallest species of the genus so far described. The largest specimen is slightly narrower than 20 mm, somewhat less than large specimens of *T. madisonense* (Haynes, 1916). Although size is significant, the major differences between *T. obscurum* and the species described by Sartenaer (1969) are in the ornament. Sartenaer's (1961a) cited species *T. uralicum* Nalivkin (1947) and *T. dunbarens* (Haynes, 1916) are usually multicostate and have from two to five costae in the fold. The flanks of these species are variable from smooth to having numerous costae.

Family CAMAROTOECHIIDAE Schuchert, 1929

Subfamily CAMAROTOECHIIDAE Schuchert, 1929

Genus CAMAROTOECHIA Hall and Clarke, 1893

Camarotoechia latisinuata new species

Plate 19, figures 51–65; plate 40, figures 20–25

About medium-sized for genus, wider than long; subpentagonal to broadly ovate in outline; maximum width located anterior to midvalve; posterolateral extremities nearly straight or slightly curved; sides convex and anterolateral extremities narrowly rounded. Valves subequally convex. Beak low and usually closely appressed onto the dorsal umbo; apical angle 113° to 127°. Anterior commissure broadly uniplicate. Surface multicostate, flanks on each side marked by five or more costae, fold by eight and sulcus by one less. Costae narrow and rounded, increasing by bifurcation and implantation.

Ventral valve gently convex in lateral profile and most convex in the posterior half; anterior profile broadly concave. Umbonal region moderately swollen; posterolateral slopes rounded; sulcus originating on umbonal region about five mm anterior to beak, widening and deepening rapidly to occupy about 0.8 the valve width at the front; tongue long and broadly rounded.

Dorsal valve slightly deeper than ventral valve, moderately convex in lateral profile, unevenly and strongly domed in anterior profile, median region rising slightly above flanks. Fold broad and gently convex in profile, originating on umbo and rising gradually anteriorly; flanks convex, steep and well-depressed below the fold.

Ventral valve interior having very short and thin dental plates and a small, triangular strongly impressed muscle field. Dorsal valve with thin, blade-like median septum expanded at the proximal end where it joins the cardinalia.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	thick- ness	apical angle
USNM 200945a (Holotype; loc. 522)	20.6	19.0	22.2	13.0	125°
USNM 900945b	18.0	17.6	23.0	10.1	127°
USNM 200945c	17.8	16.7	19.8	11.0	116°

Diagnosis.—Multicostate *Camarotoechia* having a wide sulcus and fold bearing seven and eight costae respectively.

Stratigraphic occurrence.—Thoroughgood Formation.

Locality.—522.

Types.—Holotype: USNM 200945a. Figured Paratypes: USNM 200945b–e. Unfigured Paratype: USNM 200945f.

Discussion.—This species strongly resembles specimens of *Camarotoechia multicostata* (Hall, 1860a), *C. mesacostalis* (Hall, 1843) and *C. sinuata* (Hall, 1867). This is a smaller and less strongly costate species than the first; it is larger and has more strongly costate flanks than the second; it is also larger than the third, has a wider sulcus, stronger costae on the flanks and has its maximum width farther to the anterior.

Camarotoechia latisinuata is common in the Thoroughgood Formation at Sly Gap.

Camarotoechia? species

Plate 18, figures 18–22

A single specimen, possibly an immature one, was found in the Percha Formation (Box Member) at Bear

Mountain. The fold and sulcus are well-defined respectively by four and three costae and the flanks have two incipient costae. The specimen is too small to relate to other species from Upper Devonian rocks and its reference to *Camarotoechia* is based on exterior characters alone.

Measurements (in mm): USNM 203506: length 9.8, dorsal valve length 9.4, width 9.6, thickness 5.2, apical angle 112°.

Stratigraphic occurrence.—Percha Formation (Box Member)

Locality.—509b.

Types.—Figured Specimen: USNM 203506.

Discussion.—This specimen does not suggest the young of *Paurorhyncha* Cooper (1942), which are usually flatter and widely triangular, rather than nearly circular.

Genus *CALVINARIA* Stainbrook, 1945

Calvinaria bransoni Stainbrook

Plate 18, figures 23–27; plate 19, figures 22–50; plate 40, figures 32–39

Calvinaria bransoni Stainbrook, 1948, p. 774, pl. 2, figs. 12–14 (not figs. 15, 16); McLaren, 1962, p. 24, 30, text-fig. 6A (p. 28).

This species was compared by Stainbrook (1948) to *Calvinaria ambigua* (Calvin, 1878) that occurs in the Independence Formation, but *C. ambigua* is a much bigger shell and the differences are obvious. Comparison is better made with *Calvinaria albertensis albertensis* (Warren, 1928) redescribed and illustrated by McLaren (1962). The two species share many characters, and McLaren remarks “It is considered likely that *C. bransoni* belongs to the same species group as *C. albertensis* but is subspecifically distinct.” After studying several hundred specimens of *C. bransoni*, we believe that its characters are sufficiently strong and distinct from those of the Alberta species to warrant full specific value to *C. bransoni*.

C. bransoni is a less transverse species than *C. albertensis*. Measurements of 45 specimens between 13 and 21 mm wide from each of two localities (506c and 509h) yielded a mean W/L ratio of 1.18 in the first locality and 1.19 in the second. According to McLaren’s figures (1962, p. 29) the same ratio for specimens of *C. albertensis* ranging from 13 mm to the maximum width yielded a mean W/L ratio of 1.33–1.34, indicating a more transverse species. Other differences appear in the more pronounced costation of fold, sulcus and flanks of the New Mexico species. McLaren mentions that about a third of the shells of the Alberta species develop more than two costae on the fold. This feature was seen in only six specimens in the entire collection of slightly more than 500 specimens from New Mexico.

Calvinaria bransoni is also a variable species, the variation being expressed in shape as well as ornament. Some specimens are rounder than others but generally the maximum width remains close to mid-valve. A few specimens have subdued costae, especially those at locality 521d. The New Mexico species is thin-shelled, as a rule, and the thickness of the species is variable but tends to be less than that of *C. albertensis*. The latter has a mean T/L ratio of 0.70 for specimens in the 13.0 mm to maximum width size class for the species. Forty-five specimens of *C. bransoni*, of the same range of measurement, have a mean T/L ratio of 0.61, indicating a more compressed shell than that of *C. albertensis*.

Calvinaria bransoni is most abundant in the Sacramento Mountains, especially at localities 506c and 509h. It is fairly common in the San Andres Range, but its abundance there is not comparable to that in the Sacramento Mountains. West of the San Andres Range it is rare. In general, the Sly Gap is less fossiliferous in the more western localities of the formation.

Measurements of illustrated specimens (in mm).—

	length	dorsal valve length	width	thick- ness	apical angle
USNM 135269 (Holotype; loc. 506c)	15.9	15.0	18.4	10.5	144°
USNM 135270 (M.A.S. paratype)	17.6	16.8	20.8	10.3	144°
USNM 200861a (loc. 509h)	16.0	15.0	20.4	10.6	148°
USNM 200861b (loc. 509h)	17.2	16.4	20.8	11.7	150°
USNM 200861c (loc. 509h)	17.0	16.3	21.0	11.4	151°
USNM 200856 (loc. 509h)	14.3	13.7	19.6	8.5	148°
USNM 200857 (loc. 521e)	14.5	13.8	19.6	8.6	149°
USNM 200858 (loc. 521k)	16.7	16.0	22.0	10.5	150°
USNM 200860 (loc. 526k)	17.8	16.8	22.8	11.0	144°

Diagnosis.—Strongly costate *Calvinaria* having two prominent costae defining the fold and one in the sulcus.

Stratigraphic occurrence.—Sly Gap Formation (upper part); Hackberry Formation (Cerre Gordo Member).

Localities.—506c, i, j, v, y; 509f, h, j, n, q, s, v, z; 521c, d, e, k, m, r, s, v; 523c; 524u, v, w; 526e, k; 528d, 529x.

Types.—Figured Hypotypes: USNM 200856b, d; 200857; 200858; 200859; 200860; 200861a, e.

Discussion.—It is interesting to record the presence

of *Calvinaria* in the Cerro Gordo Member of the Hackberry Formation. This specimen seems to accord well with *C. bransoni* (Pl. 19, figs. 46–50) even though it is slightly damaged. The specimen (USNM 200859) measures (in mm): length 15.7, length of dorsal valve (L) 15.2, width (W) 18.0, thickness (T) 10.4, apical angle 115° , W/L ratio = 1.15, T/L ratio = 0.66. The apparent roundness of the specimen is due to a small amount of lateral compression. It is also likely that this small distortion accounts for an apical angle that is relatively small compared to that usual in *C. bransoni*.

Genus **LEIORHYNCHUS** Hall, 1860a

Leiorhynchus sphaericum new species

Plate 19, figures 11–21

About medium-sized for genus, globular, nearly circular in outline; valves unequal in depth, dorsal valve having greater depth. Sides broadly rounded, posterior somewhat narrowly rounded and anterior margin truncated. Apical angle 106° to 128° . Anterior commissure strongly uniplicate. Ventral beak low, in some specimens not extending posterior to dorsal umbo but always pressed down on dorsal valve. Exterior sparsely costate at anterior but smooth posteriorly. Fold marked by three or four broad, low costae, sulcus by one less, flanks unmarked.

Ventral valve moderately convex in lateral profile but with the anterior tongue fairly strongly geniculated; anterior profile gently and broadly convex. Posterolateral regions steep; umbonal region somewhat swollen and marked by initial appearance of costae appearing in sulcus, which begins just anterior to midvalve; sulcus abrupt and wide, occupying two-thirds valve width; tongue long and anteriorly truncated.

Dorsal valve almost hemispherical in lateral profile and strongly and narrowly domed in anterior profile, the sides being almost straight. Umbonal, median and flank regions inflated. Costation of fold appearing just anterior to umbo, not forming a fold until about midvalve; fold inconspicuous and only slightly raised above flanks.

Measurements (in mm).—

	length	dorsal valve length	width	thick- ness	apical angle
USNM 200851 (Holotype; loc. 522l)	17.6	17.6	17.8	15.0	120°
USNM 200893 (loc. 523e)	17.0	16.4	16.3	12.8	106°
USNM 201187a (loc. 509f)	18.6	18.6	17.3	16.8	115°
USNM 201187b (loc. 509f)	16.5	16.4	15.1	12.2	114°

Diagnosis.—Small, globular *Leiorhynchus* having coarse anterior costae.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522f, l, m; 523d, e; 524x; 3025a.

Types.—Holotype: USNM 200851. Figured Paratype: USNM 200893. Unfigured Paratypes: USNM 201187a, b.

Discussion.—This species is suggestive of *Leiorhynchus castaneum* (Meek, 1867) in the strictest sense. As that species is now understood, it includes a large number of specimens much larger than the holotype, which is a small specimen (McLaren, 1962, p. 83). The type specimen of *L. castaneum* (Meek, 1867) (USNM 13854) measures (in mm): length 21.5, length of dorsal valve 21.5, width 20.0, thickness 15.2, apical angle 127° . Although the dimensions of this specimen are close to those of *L. sphaericum*, as listed above, other differences readily separate the two. The anterior tongue of the New Mexico species is more strongly geniculated, the costae are stronger on fold and sulcus, and the dorsal valve is nearly hemispherical. No other species of *Leiorhynchus* known to us or in the National Collections is like this one.

Leiorhynchus sphaericum is rare. Most of the specimens in the collection come from Mud Springs Mountains, but a single specimen was found in Rhodes Canyon and two were taken in the Caballos Mountains, all from the shaly facies of the Oñate.

Genus **PLATYTERORHYNCHUS** Sartenaer, 1970

Platyerorhynchus obscurum new species

Plate 20, figures 39–48

Large, roundly subpentagonal in outline; sides rounded; cardinal extremities rounded; anterior margin truncated; apical angle 123° . Anterior commissure strongly uniplicate. Beak small, strongly incurved and pressed to dorsal umbo. Dorsal valve deeper than ventral one. Posterior half of exterior smooth or nearly so, anterior irregularly costate, fold having four to six costae and sulcus five; flanks usually without costae.

Ventral valve moderately convex in lateral profile, broadly and gently convex in anterior profile. Posterior and posterolateral areas strongly swollen; sulcus originating abruptly at about midvalve, wide and shallow, occupying two-thirds the valve width; flanks bounding sulcus gently convex and only slightly raised above sulcus; tongue long and broadly rounded.

Dorsal valve gently convex in lateral profile with the most curvature in the umbonal region. Anterior profile strongly domed, flanks gently convex and very steep. Umbonal region swollen; umbolateral slopes steep; fold originating at midvalve, elevating moderately anteriorly, where it is fairly strong at front margin.

Ventral valve interior having small teeth, obsolescent dental plates and narrowly triangular muscle field set deeply into adventitious tissue. Dorsal valve interior with strong, elevated socket ridges, thick outer hinge plates, strong, narrow, elevated crural bases and long slender distally expanded crura. Median septum varying from sharp and blade-like to thick and massive. All hinge structures strengthened and softened in contour by adventitious shell.

Measurements (in mm).—USNM 200877 (Holotype): length (L) 28.6, dorsal valve length 26.2, maximum width (W) 29.1, thickness 18.3, apical angle 123°, L/W ratio = 0.98.

Diagnosis.—Large *Platyterorhynchus* having a costate fold and sulcus but smooth flanks.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522d, e, i, j, m; 523s, u, w, x, y, z; 524a, b, g, h, j, k; 526h, n, o, p, v; 528u; 529j, k, n, q, t, w; 3013; 3023c; 3025a; 3052a.

Types.—Holotype: USNM 200877. Figured Paratypes: USNM 200840; 200878a, d. Unfigured Paratypes: USNM 200878b, c, e, f.

Discussion.—This species is akin to a number of Camarotoechiidae Schuchert (1929) occurring in Middle Devonian strata of the eastern United States. It is similar to some forms of "*Camarotoechia*" *multicostatum* (Hall, 1860a) but that species, as its name implies, is strongly costate on fold, sulcus, and flanks. This is true also of "*C.*" *laura* (Billings, 1860), from Ontario, but that species is more triangular and also more costate than *Platyterorhynchus obscurum*. "*Camarotoechia*" *kelloggi* (Hall, 1867), from Ohio, is a smaller and more costate species. *Platyterorhynchus russelli* (McLaren, 1962), type of the genus from the Waterways Formation in Alberta, is more strongly costate than *P. obscurum*.

This species is common in the upper part of the Oñate Formation in the Sacramento Mountains but is rare in the San Andres Range.

Genus **HYBORHYNCHELLA** Cooper, 1955

Hyborhynchella bransoni Cooper

Plate 20, figures 33–38; plate 21, figures 14–31;
plate 41, figures 1–7

Hyborhynchella bransoni Cooper, 1955, p. 62, pl. 12, figs. 1–11, text-fig. 1A, 1–9.

This is such a rare species that very few specimens have been collected. It is found most frequently in the Sacramento Mountains but it also has been taken in the Mud Springs and San Andres Mountains, where it is very rare indeed.

Although serial sections were made of several specimens, little new information was obtained on the interior details of the genus. The new sections reveal the same adventitiously-thickened dorsal umbonal region and cryptic hinge plates. The crural bases are revealed as stout but no new information was obtained on the crura.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, i; 509g, h, j, w; 521c, d; 524m; 3025a; 3054h.

Types.—Holotype: USNM 123344b. Figured Paratypes: USNM 123343a, c; 123344a, c, primary types figured in Cooper (1955). Unfigured Paratypes: USNM 123343b, d–f; 123344d–j. Figured Hypotypes: USNM 201062; 201063; 201064a; 201069.

Genus **PAURORHYNCHA** Cooper, 1942

Paurorhyncha cooperi Stainbrook

Plate 20, figure 49; plate 40, figure 40

Camarotoechia (*Plethorhyncha*) *endlichi* (Meek) (part) Kindle, 1909, pl. 6, figs. 11, 11a; pl. 7, figs. 1, 2.

Camarotoechia endlichi (Meek) Girty, 1900, p. 56, pl. 6, figs. 1–3; pl. 7, figs. 1a–e.

Paurorhyncha sp. Cooper in Shimer and Shrock, 1944, pl. 119, figs. 23–26.

Paurorhyncha cooperi Stainbrook, 1947, p. 315, pl. 47, figs. 1–5.

This is one of the commonest and most distinctive of all the Percha (Box Member) brachiopods. It has been well described by Stainbrook but its interior details are not well known. Fortunately, a few specimens in the National Collections show some of the details of this species. Other information is displayed in serial sections.

The ventral valve has short and delicate dental plates that support small, sharp teeth. The ventral muscle field is somewhat longitudinally elliptical in outline with some thickening on the lateral margins. The diductor scars are small.

The dorsal valve has a short but elevated median septum that supports a small, short and wide apical chamber, which is partially covered by narrow inner hinge plates. The outer hinge plates are narrow or nonexistent, the crural bases being attached directly to the wall of the stout socket ridges. Crural bases thick, triangular in cross section; crura stout but their full extent not seen.

Stratigraphic occurrence.—Percha Formation (Ready Pay Member; Box Member).

Localities.—506, a, b, p, q; 507a, d, f, g, h, n, o, t, v, w, x, y; 509b, d, e; 527a, d, e, g; USGS (Kirk) 460; 461; 508; 509; 512; 3026, a; 3029; 3030; 3031a, b; 3034; 3042, s.

Types.—Holotype: M.A.S. 1603a (=USNM 135238). Figured Paratypes: M.A.S. 1603b–d (not in National Collection) primary types figured by Stainbrook (1947). Figured Specimens: USNM 108212a; 108211a. Figured Hypotypes: USNM 200815; 200816.

Family YUNNANELLIDAE Rzhonsnitskaya, 1959

Genus EOPARAPHORHYNCHUS Sartenaer, 1961a

Eoparaphorhynchus mclareni Sartenaer

Plate 18, figures 28–30

A single poorly preserved specimen is referred to this species. Most of the shell has been altered or destroyed, consequently fine radial lines are not visible on the surface. The specimen has a fold made up of three strong angular costae, and the flanks are marked by two costae.

Measurements (in mm).—USNM 201091: length 18.9, dorsal valve length 16.3, width 21.4, thickness 13.0?, apical angle 104°.

Stratigraphic occurrence.—Percha Formation (Box Member).

Locality.—3029.

Types.—Figured Hypotype: USNM 201091.

Genus POROSTICTIA Cooper, 1955

Porostictia perchaensis (Stainbrook)

Pugnax pugnax Kindle (not Martin, 1809), 1909, p. 22, pl. 6, figs. 3, 4–4b, 5, 6–6b (not figs. 7, 7a, 8, 8a).

Paraphorhynchus perchaensis Stainbrook, 1947, p. 316, pl. 47, figs. 6–8 (not figs. 9–13).

Porostictia perchaensis (Stainbrook) Cooper, 1955, p. 62, pl. 14, figs. 8–18, text-fig. 1C, 11–20.

This species is commonest in the lower part of the Percha Formation (Box Member), especially in the vicinity of the Wilson Ranch, Hillsboro (15') Quadrangle and east of Santa Rita.

Localities.—506, a, b, q; 507a, b, h, q; 509a, c; 527c, d, i; 3026; 3026a; 3042, s.

Types.—Holotype: M.A.S. 1596 (=USNM 155807) figured by Stainbrook (1947). Figured Specimens of Kindle (1909): *Pugnax pugnax* Kindle (not Martin, 1809) (=USNM 62019a–d). Figured Hypotypes of Cooper (1955): USNM 123394a; 123395a–c; 123396a.

Genus EVANESCIROSTRUM Sartenaer, 1965

Evanescirostrum glabraventrum (Stainbrook)

Plate 19, figures 7–10

Shumardella glabraventra Stainbrook, 1947, p. 317, pl. 47, figs. 14–18.

Evanescirostrum glabraventra (Stainbrook) Johnson, Reso, and Stevens, 1969, p. 1357, pl. 158, figs. 1–15.

This is an uncommon species in the Rhodes Canyon Formation, rather than the Percha Formation as originally described by Stainbrook. The species has a stout median septum and short apical chamber that is covered by thin inner hinge plates that in turn are continued forward from the end of the chamber. The crura are long and flattened.

Localities.—524o; 528c.

Types.—Holotype: USNM 135258 (not figured herein). Figured Paratypes: USNM 135259a, b, specimens figured by Stainbrook (1947).

Evanescirostrum species 1

Plate 19, figures 1–6

About normal size for genus, wider than long and with widest part at midvalve. Fold consisting of three strong rounded costae developed somewhat posterior to midvalve. Fold moderately elevated anteriorly. Sulcus wide, moderately deep, occupying about two-thirds of midwidth. Sulcus occupied by two strong costae.

Interior of ventral valve with short dental plates. Interior of dorsal valve having a long slender median septum reaching nearly to midvalve and supporting a small apical chamber.

Stratigraphic occurrence.—Thoroughgood Formation.

Locality.—522.

Types.—Figured Specimen: USNM 201042.

PETASMARIA new genus

[Gr. *petasma* = anything spread out]

About medium-sized for a rhynchonellid, wider than long, outline widely elliptical; valves unequal in depth, dorsal valve having greater depth than ventral; anterior commissure strongly uniplicate. Beak small, closely pressed onto dorsal umbo. Deltidial plates small, disjunct; foramen small, mesothyridid. Surface strongly costate, costae not reaching beaks, some costae increasing by implantation and some by bifurcation; fine radial lines appearing on costae in anterior parts of shell.

Ventral valve interior having strong, long dental plates. Dorsal valve interior with long median septum supporting a short, narrow, uncovered septalium. Socket ridges strong; outer hinge plates broad. Crura somewhat triangular in section.

Type species.—*Petasmaria patens* n. sp.

Diagnosis.—Large Yunnanellidae having a widely elliptical outline and multicostate shell.

Comparison.—*Petasmaria* is somewhat suggestive of *Rugaltarostrum* Sartenaer (1961a) internally, but it differs in exterior and some interior characters. It has

more strongly costate shells, especially on the flanks, whereas *Rugaltarostrum* generally has smooth flanks or only slight costation; *Petasmaria* is generally a more strongly folded shell and has a narrower fold and sulcus. Inside the dorsal valve, the outer hinge plates are wider than those of *Rugaltarostrum* and the septalium is short, small and shallow.

Petasmaria is wider and more strongly uniplicate than *Eoparaphorhynchus* Sartenaer (1961a), which usually has a much narrower and more triangular shell than species of the Percha genus. Some difficulty may be experienced in separating *Porostictia* Cooper (1955) from *Petasmaria*. The two occur together but, in addition to its punctate ornament, *Porostictia* is a squarish rhynchonellid and is not widely extended, as is *Petasmaria*. There is external resemblance of the Mississippian *Pleuropugnoides* Ferguson (1966) to *Petasmaria*. The Devonian genus however, possesses a strong median septum, a structure not found in *Pleuropugnoides*.

***Petasmaria compacta* new species**

Plate 20, figures 22–32

Small, transversely elliptical to subpentagonal in outline; sides narrowly rounded; anterior margin truncated. Anterior commissure strongly uniplicate. Beak small, closely pressed onto the dorsal valve umbo. Foramen small, mesothyridid?. Beaks smooth. Apical angle about 120°. Surface, except for beaks, costate; costae few, wide and subangular, two to four on fold, one to three in sulcus; flanks marked by two strong and one incipient costa. Fine radial capillae on surface where exfoliated.

Ventral valve gently convex in lateral profile, deeply concave in anterior profile, with the anterolateral extremities rising strongly on each side. Sulcus deep and short, originating four mm anterior to the beak and extended as long, narrowly-rounded, strongly serrate tongue. Flanks narrow, flattened. Fold steep-sided, in some specimens bearing one costa on each slope.

Dorsal valve much deeper than ventral valve, moderately convex in lateral profile, and strongly trilobed in anterior profile; fold narrowly rounded, originating just posterior to midvalve; umbonal region having a shallow, narrow sulcus from which a bifurcating costa arises to form the principal two costae of the fold.

Ventral valve interior with dental plates; dorsal valve interior having a strong median septum.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	thick- ness	apical angle	height
USNM 200942a (Holotype; loc. 507o)	10.7	10.0	13.9	8.0	121°	10.7
USNM 200942b	10.3	9.9	13.2	7.7	127°	9.5
USNM 200942c	12.4	11.9	13.7	7.8	118°	9.8
USNM 200942d	11.4?	11.0	14.8	7.5	118°	8.2

Diagnosis.—Small *Petasmaria* having few, strong costae.

Stratigraphic occurrence.—Percha Formation (Box Member).

Locality.—507o.

Types.—Holotype: USNM 200942a. Figured Paratype: USNM 200942b. Unfigured Paratypes: USNM 200942c–g.

Comparison.—Although this species is ornamented unlike *P. patens* n. sp. and *P. multicostata* n. sp., it has the general outline and fold and sulcus development of *Petasmaria*. In addition, it has the capillae on exfoliated areas shown in the larger species of the genus. The species is rare and was found at only one locality.

***Petasmaria multicostata* new species**

Plate 21, figures 1–5

About normal size for genus, wider than long, widely elliptical in outline. Sides narrowly rounded, anterior truncated. Anterior commissure strongly uniplicate. Ventral beak small, not protuberant. Apical angle 141°. Beaks smooth. Surface, except for beaks, costate; costae narrowly subangular, increasing by bifurcation and implantation. Strong concentric wrinkles undulating over costae on flanks.

Ventral valve gently convex in lateral profile but deeply concave when viewed from anterior. Sulcus deep and wide, originating about five mm anterior to beak, and extended into long, rounded and distally serrate tongue. Flanks angular and extended strongly beyond sulcus. Eight costae occupying the sulcus, the median one largest and widest. Flanks marked by five costae.

Dorsal valve triangular in lateral profile and forming an angle of about 50°. Anterior profile strongly trilobed, tongue and fold forming a large median lobe; rounded, moderately convex flanks forming the smaller lateral lobes. Fold elongated, moderately rounded in transverse section, occupied by nine costae, the

median two bifurcating on umbo and matching median one of tongue. Flanks marked by five costae and an incipient sixth. Umbonal region with a shallow narrow sulcus just posterior to median costae.

Measurements (in mm).—USNM 200940 (Holotype): length 11.0, dorsal valve length 11.4, maximum width 20.2, thickness 14.6, apical angle 141°, height 15.8.

Diagnosis.—*Petasmaria* having exaggerated ventral tongue, numerous costae having concentric wrinkles, and length about half the width.

Stratigraphic occurrence.—Percha Formation (Box Member).

Locality.—506b; 509e.

Types.—Holotype: USNM 200940.

Discussion.—This species differs from *P. patens* n. sp., in its anterioposterior compressed form, narrowly elliptical outline, exaggerated fold and sulcus, and numerous costae. In addition to the concentric markings, exfoliated patches show some fine radial capillae.

***Petasmaria patens* new species**

Plate 20, figures 1–21; plate 21, figures 6–13; plate 42, figures 27–32; plate 44, figures 1–10

Pugnax pugnax Kindle (not Martin, 1809) 1909, p. 22, pl. 6, figs. 8, 8a (only).

Paraphorhynchus perchaensis Stainbrook (part), 1947, p. 316, pl. 321, figs. 9–13 [not figs. 6–9 = *Porostictia perchaensis* (Stainbrook)].

A fairly large rhynchonellid, elliptical in outline, wider than long; sides narrowly rounded; anterior margin broadly rounded to truncated. Posterior margin broadly obtuse and forming angle of 130–145° in adult. Anterior commissure strongly uniplicate. Ventral beak small, low, closely pressed onto dorsal umbo in large adults. Foramen small, mesothyridid?; deltidial plates small, disjunct. Umbo narrowly convex to subcarinate. Valves costate; costae narrowly rounded to subangular, originating just anterior to umbones, which are smooth. Costae variable, bifurcating and implanted; sulcus with three to seven, fold with three to ten costae, some formed on slope of fold not meeting the sulcus. Flanks usually with three or four strong costae. Fine radial lines often present on the flanks, especially posterolaterally.

Ventral valve flatly convex in lateral profile; anterior profile deeply concave with the flanks strongly elevated; flanks narrow, flat to slightly convex. Sulcus originating just anterior to umbo (three to four mm measured on the surface), widening very rapidly and forming a long, narrow strongly serrated tongue. Sides of sulcus steep.

Dorsal valve moderately convex in lateral profile but strongly domed in anterior profile, the dome having an elevated, narrow median lobe and moderately convex lobes on its sides. Umbo concave. Fold originating about three mm anterior to beak, usually with three costae, the outer two often bifurcating or trifurcating; development of costae on the fold is quite variable. Costae on flanks broad and strongly curved to the margins.

Ventral valve interior with strong and long dental plates. Dorsal valve interior with divided hinge plate having slender but strong socket ridges, wide outer hinge plates and short, shallow septalium supported by a long median septum. Crura triangular in section.

Measurements (in mm).—

	length	dorsal valve length	width	thick- ness	apical angle
USNM 200939 (loc. 507o)	16.3	15.9	24.1	18.0	133°
USNM 200943a (loc. 507d)	15.1	14.6	23.3	15.8	133°
USNM 201186 (loc. 507n)	16.0	15.7	28.3	13.6?	148°
USNM 200938 (loc. 507c)	15.4	16.0	23.8	19.7	130°
USNM 200937 (Holotype; loc. 507h)	14.6	14.6	23.7	23.1	140°
USNM 200941 (loc. 509)	11.2	11.0	16.2	8.1	122°

Diagnosis.—Large, wide *Petasmaria*, with extended fold bearing four to five costae.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, a, b, p, q; 507a, b, c, d, h, k, l, m, n, o, q, r, x, y; 509, 509a, b, e; 527a, d, e, f, g, h, n, p; 3026, a; 3029; 3030; 3031a; 3034, 3035; 3042, s; USGS (Kirk) 460; 461; 508; 509; 512.

Types.—Holotype: USNM 200937. Figured Paratypes: USNM 200938, 200939, 200941, 200943a, b. Unfigured Paratypes: USNM 200943c, 201185, 201186. Stainbrook (1947) figured specimens: M.A.S. 1596–155808, 155809. Kindle (1909) figured specimen: USNM 62019e.

Comparison.—*Petasmaria patens* n. sp. differs from *Porostictia perchaensis* (Stainbrook, 1947), with which it occurs and with which it has been confused, in lacking the rows of pores so characteristic of *Porostictia* Cooper (1955). It also differs in having an entirely different shape, being wider and with a more swollen and elevated median fold. *Petasmaria multicostata* n. sp. is similar to *P. patens* in shape but differs in the finer and more numerous costae.

Discussion.—The ornament of this species is highly variable as noted above. The flanks of the shell are fairly uniform in most specimens but the fold and sulcus are highly variable. The few young specimens available have a carinate ventral umbo, the carina extending anteriorly as a median costa in the sulcus. This carina corresponds to the sulcus in the dorsal umbo. Usually one or more costae are implanted in the sulcus on either side of the median rib. On the fold there are usually two primary costae that soon divide. In some specimens these further divide or intercalation takes place to produce a multicostate fold. Occasional specimens deviate so strongly in their costation as to suggest other species, but the specimens are too few to establish this as a fact.

Order **SPIRIFERIDA** Waagen, 1883

Superfamily **ATRYPACEA** Gill, 1871

Suborder **ATRYPIDINA** Moore, 1952

Family **ATRYPIDAE** Gill, 1871

Subfamily **ATRYPINAE** Gill, 1871

Genus **ATRYPARIA** Copper, 1966

Atryparia rubra new species

Plate 21, figures 38–53

Large, subquadrate in outline, length and width nearly equal but usually slightly wider than long; sides rounded posteriorly but somewhat oblique anteriorly; anterior margin narrowly truncated to narrowly nasute. Anterior commissure strongly and commonly narrowly uniplicate. Beak small, slightly or not at all protuberant beyond the posterior margin. Surface strongly costate, four costae in five mm at the front, increasing by bifurcation and implantation. Frill about eight mm wide.

Ventral valve lateral profile unequal, posterior part gently convex, anterior part geniculated gently to strongly toward dorsal valve. Anterior profile flatly convex to broadly concave depending on the degree of deflection of lateral margins. Posterior moderately and somewhat narrowly swollen to midvalve; sulcus originating anterior to midvalve, variable from broad and shallow to narrow and fairly deep. Frilled margins deflected toward ventral side in narrow band.

Dorsal valve strongly convex in lateral profile and most convex posteriorly; anterior profile strongly and fairly narrowly domed, sides gently convex and steep. Median region greatly swollen, swelling extending to the anterior where it forms a short fairly narrow fold.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	thick- ness	frill length
USNM 201005a (loc. 523o)	31.6	30.6	25.0	32.9	19.8	—
USNM 201005b	26.8	26.9	21.6	30.8	16.6	7.5
USNM 201021 (Holotype; loc. 523o)	34.0	33.9	27.0	37.4	16.6	8.0
USNM 201014a (loc. 523o)	27.8	27.2	19.8	27.3	14.9	—
USNM 201014b	27.3	27.3	23.7	29.5	16.0	6.0
USNM 201014c	24.1	24.0	20.0	29.6	14.0	7.0
USNM 201014d	25.0	24.0	21.6	27.7	13.4	7.0
USNM 201014e	28.2	27.7	26.0	32.6	17.6	—

Diagnosis.—Large frilled *Atryparia* having four costae in five mm at the anterior.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522f, l, t, v; 523a, o; 524i; 3025a.

Types.—Holotype: USNM 201021. Figured Paratypes: USNM 201005a, b. Unfigured Paratypes: USNM 201014a–e.

Discussion.—This species is similar in size and outline to *Desquamatia costata* n. sp., but differs in having stronger costae, greater development of frills, and less convex dorsal valve. This species occurs chiefly in the Caballos Range, especially at the Nackaye “Paint Mine” locality (523o).

Genus **DESQUAMATIA** Alekseeva, 1960

Desquamatia costata new species

Plate 22, figures 17–38

Large, subcircular in outline, length and width subequal; strongly inequivalve; sides rounded, anterior margin truncated to subnasute. Cardinal extremities rounded. Anterior commissure narrowly uniplicate. Beak and foramen small. Beak slightly protuberant; deltidial plates visible. Hinge narrower than maximum width, which is at midvalve. Surface costate, costae narrowly rounded, generally wider than the interspaces; imbrications distant on shell body but closely crowded at anterior. Five to seven costae in five mm at the front margin.

Ventral valve unevenly convex in lateral profile, posterior half gently convex but anterior half flattened. Anterior profile variable from gently concave to gently convex. Beak narrowly swollen; umbonal region moderately swollen to midvalve; flanks flattened and becoming slightly deflected in ventral direction near margins. Sulcus wide, developing gradually near midvalve but not becoming pronounced until near the anterior margin; tongue moderately long, narrowly to broadly rounded.

Dorsal valve strongly convex in lateral profile, strongly domed in anterior profile, sides gently convex or flat and steeply dipping to margins. Umbonal and median regions greatly swollen; slopes to cardinal extremities concave. Fold formed as a wave in anterior commissure, poorly distinguishable on valve surface except at very anterior where it may be slightly nasute.

Measurements (in mm).—

	length (L)	dorsal valve length	hinge width	maxi- mum width (W)	thick- ness	L/W ratio
USNM 200973 (loc. 522g)	31.7	30.5	22.5	35.1	18.2	0.90
USNM 200972 (Holotype; loc. 523d)	29.9	28.3	18.8	33.5	17.8	0.89
USNM 201007a (loc. 523o)	28.6	28.2	22.0	31.2	19.4	0.91
USNM 201114 (loc. 523h)	26.3	27.0	17.0	29.0	18.9	0.91
USNM 201006 (loc. 528e)	32.5	32.7	24.0	33.2	26.4	0.98

Diagnosis.—Large finely costate *Desquamatia*, with five costae per five mm at front of valve, and shallow anterior sulcus.

Stratigraphic occurrence.—Oñate Formation.

Localities.—506d; 522f, g, l, o; 523b, d, e, f, g, i, j, k, o, t, u, x, z; 524b, d, l; 526c, h; 528e; 529j, k, o; 3025; 3054f.

Types.—Holotype: USNM 200972. Figured Paratypes: USNM 200973, 201003, 201006, 201007a. Unfigured Paratypes: USNM 201007b, 200909.

Comparison.—The distinction of this species from *Atrypa rubra* n. sp. is mentioned under that species. *Desquamatia costata* n. sp. is unlike any of the species from the Cedar Valley Formation assigned to "*Atrypa*" by Stainbrook (1938). Several undescribed atrypas from Michigan and New York seem referable to *Desquamatia*, but are not identifiable with the Oñate species. *Atrypa dignata* Fenton and Fenton (1930) resembles the Oñate species but is larger, with a more convex dorsal valve, stronger fold and sulcus, and more protuberant beak.

Genus PSEUDOATRYPA Copper, 1973

Pseudoatrypa devoniana (Webster)

Plate 22, figures 1–16; plate 23, figures 32–38

Atrypa devoniana Webster, 1921, p. 19 (not pl. 8, figs. 9–11); Fenton and Fenton, 1924, p. 134, pl. 26, figs. 16–24; Stainbrook, 1938, p. 240; 1945, p. 47, pl. 5, figs. 24–26, 29–32, fig. 1 [1]; 1948, p. 776, pl. 2, figs. 23, 24, 48.

This species can be readily recognized in a collection from the Sly Gap Formation by the relatively fine

ornament. As pointed out by Stainbrook (1945), it is variable, not only as to size and shape but in development of fold and sulcus and in ornament. Much of the material from the Sly Gap is so badly weathered that the ornament is difficult to compare with well-preserved specimens. Most of the material consists of very costellate young specimens; adults are rare and often variable. The sulcus at the anterior is usually fairly wide, occupying nearly one-third of the valve width. No sharply folded specimens, as occasionally occur in large collections from the Hackberry (Cerro Gordo Member) Formation, were seen. Occasional specimens preserve the frill, which is narrow, about seven mm wide on a specimen 21 mm in length.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	thick- ness
USNM 200965 (loc. 509s)	21.0	20.0	9.1	21.6	12.7
USNM 200964 (loc. 509z)	21.3	20.5	9.9	21.8	13.8
USNM 201018 (loc. 506j)	25.6	25.2	13.0	26.0	17.6
USNM 200927 (loc. 521m)	17.3	16.4	11.8	20.0	10.1
USNM 200944 (loc. 521d)	26.0	25.0	16.9	26.6	17.5

Diagnosis.—Medium-sized, fine-lined *Pseudoatrypa* with moderately strong anterior fold.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, j, v; 509g, h, i, n, r, s, y, z; 521c, d, e, k, m, q, s, t, u, w, y; 523m, n, u, w; 526k, s; 529v; 3054f; USGS (Kirk) 538.

Types.—Figured Hypotypes: USNM 200927, 200944, 200964, 200965, 200966, 201094.

Genus COSTATRYPA Copper, 1973

Costatrypa extensa new species

Plate 23, figures 39–56; plate 24, figures 1–12

About medium in size for genus, subrectangular to semielliptical in outline; hinge wide but variable, equal to or wider than midvalve but usually slightly narrower; sides nearly straight to oblique; anterior broadly rounded. Beak and foramen small; valves shallow and shell compressed. Valves costate, costae fine and separated by spaces about equal in width to width of costae or wider; four to six costae in five mm at midvalve and the anterior margin. Entire surface covered by lamellae, distant posteriorly but becoming crowded toward the anterior. Frills narrow but attaining a width of nine mm and having coarser costae than the shell body.

Ventral valve moderately convex in lateral profile, most convex posteriorly and with anterior gently geniculated for form small rounded tongue. Anterior profile broadly concave when frilled but moderately convex when frill is lacking, with median region forming small mound. Median region from beak to midvalve slightly swollen but from there to anterior depressed to form broad but shallow sulcus.

Dorsal valve fairly strongly and evenly convex in lateral profile, broadly domed in anterior profile, and having fairly steep sides that become concave near margins. Median region strongly swollen and anteriorly forming a poorly defined fold, best seen by viewing anterior commissure.

Ventral valve interior with a narrow, small, oval deeply impressed muscle area.

Measurements (in mm).—

	dorsal length	valve length	hinge width	maxi- mum width	thick- ness	frill length
USNM 200984 (Holotype; loc. 521k)	19.4	18.2	23.5	27.2	10.0	8.4
USNM 200993 (loc. 521k)	16.6	16.0	20.5	24.0	9.2	6.6
USNM 200983 (loc. 521k)	16.4	15.7	19.6?	22.2	9.0	—
USNM 200967 (loc. 506j)	14.6	13.7	18.0	23.0?	7.2	5.7
USNM 200960a (loc. 521d)	14.7	14.2	14.6?	18.2	8.5	—
USNM 200960b (loc. 521d)	14.6	14.2	23.0*	22.0	7.1	7.7
USNM 200951a (loc. 3054)	14.0	13.5	18.0	19.6	8.1	5.0
USNM 200951b (loc. 3054)	14.6	13.7	24.0*	24.0	7.1	8.2

Diagnosis.—Shallow, compressed, finely costate *Costatrypa* having a short wide anterior sulcus on ventral valve and with fairly wide marginal frill.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, j; 509f, p; 521d, e, k, m, u, w; 524m, v; 526s; 529y; 3054, c; USGS (Kirk) 538.

Types.—Holotype: USNM 200984. Figured Paratypes: USNM 200951a, b, 200960a, 200967, 200983, 200993. Unfigured Paratype: USNM 200960b.

Discussion.—This species is distinguished from all others in the Sly Gap Formation by its transverse outline, shallow valves, broad, short sulcus and ill-defined dorsal valve fold. The species is distinctive, but is not always easy to separate from young specimens of *C. varicostata* (Stainbrook, 1945).

The development of the ornament on this species and on *C. varicostata*, as well as on *Spinatrypa* Stainbrook (1951), is similar. The beak of the ventral valve

starts with a single costa that bifurcates almost immediately on appearance, and the beak of the dorsal valve starts with two costae that form a shallow sulcus in which a single costa is implanted not far anterior to the beak. All of the costae may bifurcate and some costae are implanted.

Costatrypa varicostata (Stainbrook)

Plate 23, figures 7–31

Atrypa varicostata Stainbrook, 1945, p. 47, pl. 5, figs. 13–17.

Atrypa variacostata [sic] Stainbrook, 1948, p. 776, pl. 2, figs. 44–47.

This and *C. extensa* n. sp. are the commonest and perhaps most distinctive brachiopods in the Sly Gap Formation. They occur in countless numbers in the exposures on Sheep Mountain. The large quantities of specimens available show them to belong to an extremely variable species. The distinctly shouldered posterior margin of *C. varicostata*, and ornament coarser than that of *Pseudoatrypa devoniana*, serves to separate these two species.

The valves of *C. varicostata* are unequal in depth. The ventral valve is the shallower and is marked by a pronounced fold that originates anterior to midvalve and varies from fairly wide to narrow and produces a tongue with angular to narrowly rounded extremity. The dorsal valve fold originates near midvalve and varies from narrowly rounded to moderately rounded.

The ornament of the pedicle valve in *C. varicostata* begins with a single costa at the beak that immediately divides, and between the resulting two another is inserted. All of the costae are divided two or three times to the margin. The beak of the dorsal valve has an initial sulcus in which a costa is inserted. Costae are increased by insertion and division as on the ventral valve. The valves are covered by imbricating, closely-spaced lamellae that become crowded anteriorly. Frills narrow.

Measurements (in mm).—

	dorsal length	valve length	hinge width	maxi- mum width	thick- ness	frill length
USNM 200992 (loc. 506c)	16.2	15.8	7.8	19.4	14.2	—
USNM 200963 (loc. 3054b)	21.6	19.5	10.5	24.2	13.8	—
USNM 200996 (loc. 521d)	17.6	16.4	9.0	17.9	14.2	—
USNM 200979a (loc. 3054)	16.2	15.6	13.3	20.0	11.2	4.1
USNM 200979b (loc. 3054)	18.3	17.6	17.0	22.5	13.0	—

Diagnosis.—Compact, moderately strongly costate *Costatrypa* having fold and sulcus anterior to midvalve.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, e, j, y; 509f, g, i, p, v, z; 521d, e, k, l, m, q, t, u, v, w, x; 522k, x; 523m; 524m, n, v, w; 526d, e, s; 528p; 529p, u, y; 3054b, i; USGS (Kirk) 534; 538.

Types.—Figured Hypotypes: USNM 200963, 200979a, b, 200992, 200994, 200996, 201004.

Discussion.—See under *Costatrypa extensa* n. sp.

Genus **IOWATRYPA** Copper, 1973

Iowatrypa rara new species

Plate 24, figures 15–29

Small, generally slightly longer than wide; unequally biconvex, the ventral valve having deeper shell in adults. Outline subrectangular with subparallel sides, obtusely rounded cardinal extremities and rounded anterolateral extremities and truncate anterior margin. Anterior commissure gently and narrowly uniplicate. Hinge narrower than maximum width, which is just anterior to cardinal extremities. Posterolateral margins having an angle of about 120°. Interarea short and curved; beak small, incurved; foramen small; deltidial plates conjunct. Surface as in *Atrypa* Dalman (1828), costellate, costellae increasing by bifurcation; overlapping lamellae distant posteriorly, crowded at anterior.

Ventral valve fairly strongly convex in lateral profile, narrowly domed and with steep sides in anterior profile. Umbonal and median regions strongly inflated; anterior quarter depressed to form narrow, shallow sulcus that creates short rounded tongue.

Dorsal valve moderately convex in lateral profile, less so than the dorsal valve. Anterior profile a moderately convex dome with flattened, moderately steep slopes. Umbonal region only moderately inflated but median region strongly swollen, swelling continuing to anterior margin to form poorly defined fold.

Interior not known.

Measurements (in mm).—

	dorsal valve length	hinge length	hinge width	maxi- mum width	thick- ness	apical angle
USNM 201099 (loc. 506j)	14.2	12.6	9.5	13.0	9.8	119°
USNM 201098 (Holotype; loc. 521q)	14.7	13.0	10.7	12.9	10.0	125°
USNM 203507 (loc. 521k)	11.2	10.2	7.8	11.1	6.0	131°

Diagnosis.—Fairly strongly costellate *Iowatrypa* with length greater than, or equal to, the width.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506j; 509r; 521d, k, q.

Types.—Holotype: USNM 201098. Figured Paratypes: USNM 201099, 201135a. Unfigured Paratypes: USNM 203507, 203508, 201135b.

Discussion.—This species resembles *I. americana* (Stainbrook, 1945) from the Independence Formation and *I. owenensis* (Webster, 1921) from the Owen Member of the Hackberry Formation. The New Mexico species is ornamented like the former but, according to Stainbrook (1945, p. 52), that species is typically slightly wider than long, whereas the reverse is true of *I. rara*. Webster's species is much longer than wide and has a stronger and narrower fold and sulcus than *I. rara*. A species very similar to *I. rara* occurs in the Mt. Hawk Formation of western Canada (Warren and Stelck, 1956, pl. 17, figs. 19–24; called *Gruenwaldtia* sp.).

Iowatrypa americana (Stainbrook)

Plate 24, figures 13, 14

Gruenwaldtia americana Stainbrook, 1945, p. 52, pl. 5, figs. 18–23, 27, 28; fig. 1 [6].

Two views of this species are introduced for comparison with the New Mexico species.

Stratigraphic occurrence.—Independence Formation.

Locality.—528f.

Types.—Figured Hypotype: USNM 201134a.

Genus **SPINATRYPA** Stainbrook, 1951

Spinatrypa compacta new species

Plate 24, figures 30–45

Small, subquadrate in outline, length and width nearly equal; sides slightly convex to nearly straight and subparallel; anterior margin rounded. Anterior commissure broadly uniplicate. Beak small and closely appressed onto the dorsal umbo. Hinge wide, forming small flattened ears. Dorsal valve much deeper than ventral valve. Surface distantly costate, costae becoming vague anteriorly; ventral valve umbo with an initial costa bifurcating soon after formation, the two costae extending nearly to the anterior margin and forming a narrow, low fold; umbonal costae flanking initial costae occupying the flanks. Dorsal valve umbo sulcate; sulcus occupied by a median costa about three mm anterior to the beak, it and the flanking costae extending to the anterior; eight or nine costae in all. Entire surface covered by distant concentric lamellae.

Ventral valve gently convex in lateral profile, broadly and flatly convex in anterior profile; sulcus poorly developed, defined only at anterior third. Flanks gently convex.

Dorsal valve strongly convex in lateral profile and narrowly domed in anterior profile, sides of dome nearly vertical. Fold defined only at commissure. Posterolateral slopes concave to small cardinal extremities.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	thick- ness
USNM 203538 (Holotype; loc. 528g)	20.0	19.5	17.0	21.5	13.4
USNM 200978a (loc. 523n)	17.3	16.8	13.7	17.9	11.4
USNM 200978b	17.4	16.3	16.2	18.8	13.0

Diagnosis.—Small, nearly square, paucicostate *Spinatrypa* having small flattened ears.

Stratigraphic occurrence.—Contadero Formation (top); Sly Gap Formation?

Localities.—509g?; 522a; 523n; 528g.

Types.—Holotype: USNM 203538. Figured Paratypes: USNM 203540a, b.

Discussion.—This species occurs in abundance at the top of the Contadero Formation at Sheep Mountain. It is smaller than either of the other New Mexico species and is more sparsely costate than either; its costae cover more of the valve than those of *S. obsolescens* n. sp. It is a more rotund and thicker species than *Spinatrypa rockfordensis* (Fenton and Fenton, 1924). It is suggestive of *Spinatrypa mascula* (Stainbrook, 1938) from the Cedar Valley Formation (Solon Member) but is smaller, has a straighter hinge, better defined ears, and anteriorly obsolescent costae.

***Spinatrypa obsolescens* new species**

Plate 24, figures 46–60

Medium-sized for genus, variable in outline, subrectangular to longitudinally oval; sides and anterior margin rounded; hinge narrower than widest part. Fold and sulcus moderately developed and, in some specimens, poorly defined. Surface partially costate, costae well defined only in umbonal region, the ventral valve having a median costa that divides soon after appearance, and is matched by narrow sulcus on opposite valve. Two costae on each side of median divided one on ventral umbo, making six on umbo. Dorsal valve having median costa in early fold flanked by two or three costae on each side. Costae becoming vague or disappearing anterior to the umbonal region. Entire surface covered by strong concentric lamellae. No spines seen.

Interior unknown.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	thick- ness
USNM 200962 (Holotype; loc. 526g)	21.5	21.0	20.0?	26.6	11.9
USNM 200997d (loc. 3054)	28.7	27.9	17.0?	27.3	13.6
USNM 200997b (loc. 3054)	23.7	24.0	19.0?	27.5	13.5
USNM 200997a (loc. 3054)	22.8	23.0	18.0?	24.6	12.1

Diagnosis.—*Spinatrypa* having costae vague or obsolescent anterior to the umbonal region.

Stratigraphic occurrence.—Contadero Formation.

Localities.—509t; 521j; 522a; 524t; 526g; 3054k.

Types.—Holotype: USNM 200962. Figured Paratypes: USNM 200997a, d. Unfigured Paratypes: USNM 200997b, c.

Discussion.—In the umbonal region of both valves, this species is marked like that portion of *Spinatrypa trulla decorticata* n. ssp., but the anterior parts of *S. obsolescens* are devoid of costae or show only vague traces of them. The species is not so big as *S. trulla decorticata* and can be distinguished from that form by the lack of anterior costae. The loss of costae anteriorly takes place in some specimens of *S. trulla decorticata* but usually the obsolescence has not proceeded as far as in the Contadero species. It is likely that *S. obsolescens* is descended from the Sly Gap subspecies.

***Spinatrypa trulla* (Stainbrook)**

Plate 25, figures 1, 2

Figures of *Spinatrypa trulla* (Stainbrook, 1945) are introduced for comparison with the New Mexico subspecies. *Spinatrypa trulla*, one of the commoner species in the Independence Formation of Iowa, is usually exceptionally well preserved and some specimens exhibit the spines to perfection.

Types.—Figured Hypotypes: USNM 201082a, b.

Localities.—362a; 528h.

***Spinatrypa trulla decorticata* new subspecies**

Plate 25, figures 3–40

Large, variable in shape and ornament, usually wider than long and subquadrate in outline; sides rounded; anterior margin rounded; hinge narrower than maximum width, which is at about midvalve; beak small, low, usually damaged, and always closely pressed onto the dorsal valve umbo. Biconvex, dorsal valve swollen and much deeper than ventral valve. Surface ornament variable from strongly-defined to obsolescence of some

features. Valves costate; ventral umbo usually having one costa at beak dividing almost immediately and occupying sulcus to the margin; median costa flanked at beak by two on each side, the inner two forming sides of sulcus but, like their companions on each side, often becoming vague and obsolescent. Some specimens with costae intercalated anterior of midvalve. Dorsal valve umbo marked by a median narrow sulcus corresponding to initial costa of opposite valve; sulcus occupied early in development by median costa that extends with two flanking ones to anterior margin to form the crest of median fold. Surface strongly lamellose, spines being produced at junction of costae and lamellae. Spines stout but rarely preserved.

Ventral valve variable, fairly strongly to gently convex in lateral profile, broadly and gently concave to broadly and moderately convex in anterior profile. Sulcus usually broad and shallow, originating at about midvalve and producing a broadly rounded moderately long tongue. Flanks varying from gently concave to gently convex.

Dorsal valve moderately to strongly convex in lateral profile and strongly domed with long sloping sides in anterior profile. Umbonal and median regions strongly swollen. Fold broad and low, originating at or near midvalve, seldom very prominent and strong only at anterior but pronounced in anterior view.

Interior not seen.

Measurements (in mm).—

	length (L)	dorsal valve length	hinge width	maxi- mum width (W)	thick- ness	L/W ratio
USNM 201182a (loc. 506i)	30.3	29.1	20.0?	35.7	19.4	0.85
USNM 201183a	30.4	29.8	22.0?	33.7	18.1	0.90
USNM 200998 (Holotype; loc. 509j)	31.4	30.9	23.4?	33.7	19.0	0.93
USNM 201184 (loc. 509y)	25.3	24.3	22.3	30.5	16.4	0.83
USNM 200982b (loc. 506c)	29.5	28.7	19.7?	30.0	16.0	0.98
USNM 200982f (loc. 506c)	21.8	20.9	17.3	24.4	12.2	0.89
USNM 200982d (loc. 506c)	14.6	13.9	8.7	15.8	7.1	—
USNM 200982c (loc. 506c)	12.0	11.1	8.2	12.0	5.9	1.00
USNM 200982e (loc. 506c)	10.0	9.4	6.4	10.0	5.3	—
USNM 200961 (loc. 506c)	21.8	20.8	17.0	25.1	13.5	0.87
USNM 200982a (loc. 506c)	5.3	4.7	—	5.1	2.0	—

Diagnosis.—Large *Spinatrypa* with variable ornament and strongly convex dorsal valve.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, i, j, v; 507; 509f, h, i, j, n, p, q, r, s, v, w, x, y, z; 521c, d, e, k, l, m, o, r, t; 523m; 524m, n, u?; 526f, k, s; 529s; 3054.

Types.—Holotype: USNM 200998. Figured Paratypes: USNM 200931, 200982b, d, f, 200999, 201002, 201159. Unfigured Paratypes: USNM 200961, 200982a, c, e, 201182a, 201183a, 201184.

Discussion.—This is a quite variable subspecies and, when compared to a collection of specimens of *Spinatrypa trulla* (Stainbrook, 1945), many differences may be noted in individual specimens. However, they all retain their resemblance to Stainbrook's species. The Sly Gap subspecies attains a larger size than that from Iowa and is often rounded in outline; occasional specimens are elongated. The ornament is basically that of *S. trulla* but some specimens have intercalated costae more numerous than usual in the Iowa subspecies, in which the costae tend to be fairly uniform. Many of the New Mexico specimens (e.g., USNM 201159) show obsolescence of costae anteriorly and laterally, a phenomenon rarely seen in *S. trulla*.

A few specimens of *S. trulla decorticata* vary from the main line in the development of the fold and sulcus. Specimens from localities 509y, 521o and 524u have an exaggerated fold and sulcus, the latter being narrow and very deep while the fold is also narrow and elevated from umbo to anterior margin. The crest of the fold is occupied by three costae, the median costa of the initial, juvenile sulcus and two of those flanking it on the umbo. Stainbrook (1945, pl. 5, figs. 5–7) illustrates a specimen (M.A.S. 896; Iowa University) from the Independence Formation showing the same aberrations as those shown by the Sly Gap individual (USNM 200999) from locality 524u. This is the most exaggerated specimen seen. This latter specimen measures (in mm): length 23.9, dorsal valve length 25.3, hinge width 22.0?, maximum width 33.4, and thickness 22.4.

Suborder **ATHYRIDIDINA** Boucot, Johnson, and Staton, 1964

Superfamily **ATHYRIDACEA** M'Coy, 1844

Family **ATHYRIDIDAE** M'Coy, 1844

Subfamily **ATHYRIDINAE** M'Coy, 1844

Genus **ATHYRIS** M'Coy, 1844

***Athyris transversa* (Stainbrook)**

Athyris coloradensis Kindle (not Girty, 1900), 1909, p. 24, pl. 6, fig. 9.
Cleiothyridina? coloradensis Stainbrook (not Girty, 1900), 1947, p. 327, pl. 45, figs. 25–30.
Cleiothyridina? transversa Stainbrook, 1947, p. 327, pl. 45, figs. 14, 19–22.

The frills of this species are like those of the more familiar *Athyris lamellosa* (Léveillé, 1835) of the Mississippian. Like the Percha species, the frills of this large athyrid are made up of closely compacted spine-like fibers that often give the ends of the frills a somewhat spinose appearance, but very minutely so and quite unlike *Cleiothyridina* Buckman (1906). Consequently, it seems necessary to assign the Percha species to *Athyris* M'Coy (1844) rather than *Cleiothyridina*. Stainbrook evidently had doubts about the assignment because he questioned his own use of *Cleiothyridina*.

This genus is abundant and varied in the Percha Formation (Box Member). Generally, specimens that retain much of their frilly ornament seem transverse and are assignable to this species. Specimens shorn of their frills tend to be rather rounder and suggest *C.?* *coloradensis*, as interpreted by Stainbrook. It is suggested that only one species is involved and that retention or stripping off of the frills is the clue to their identification.

Athyris coloradensis Girty (1900) from the Ouray Limestone is a much larger species than the Percha forms and cannot be so identified. Inasmuch as *A. coloradensis* is a very different species, and those specimens so assigned from the Percha can be identified with *A. transversa*, the latter name is available for the Percha species. The name is not entirely an apt one because most of the specimens are not transverse when stripped of their frills.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b, p; 507a, b, d, e, h, k, l, m, o, r, t, x; 509a, b, c, e; 527e, l, p; 3035; 3042, s; USGS (Kirk) 461.

Types.—Holotype: M.A.S. 1595A (=USNM 155779). Paratype: M.A.S. 1595B (=USNM 155780). Figured specimen of Kindle (1909): USNM 62020. Figured specimens of *C.?* *coloradensis* Stainbrook (not Girty) are not in the National Collections.

CRINISARINA new genus

[Gr. *crinis* = hair]

Shells athyridid, attaining a width of about 25 mm or less; length and width subequal; outline subpentagonal; valves biconvex, subequal in depth. Beak small, erect, with moderately large, round foramen.

Anterior commissure moderately to strongly uniplicate. Surface strongly and closely lamellate, the lamellae bearing a fringe of long, thin, solid spines.

Ventral valve interior having long stout dental plates and thick teeth. Dorsal valve interior with stout narrow hinge plate.

Type species.—*Cleiothyridina reticulata* Stainbrook, 1947, p. 326, pl. 45, figs. 31–35. Holotype: USNM 135248.

Diagnosis.—Compact, pentagonal athyridids having uniplicate anterior commissure and lamellae bearing fringes of long thin spines.

Comparison.—The brachiopods referred here have been variously placed in *Athyris* and *Cleiothyridina*. They partake of the interior details of both genera but differ in their pentagonal outline, subequal depth, dimensions and strong uniplication.

Although several species are assigned here, seldom are specimens found that have the exterior details well preserved. Fortunately, a few specimens of each species show the cleiothyridid ornament. Although many specimens are weathered smooth, some show the concentric crowded lamellae but are completely stripped of spines. It is incredible that most specimens can be so completely shorn of their hairy spines. A few specimens preserve the spines in more or less good condition. On one such specimen [*C. angelicoides* (Merriam, 1940), USNM 205263a], they are about three mm long.

The following five species are placed in *Crinisarina*: *Athyris angelicoides* Merriam (1940) (USNM 205263), *Cleiothyridina devonica* (Raymond, 1909), *C. humerosa* Stainbrook (1950), *C. reticulata* Stainbrook (1950), and *C. prouti* (Swallow, 1860). The first two are, respectively, from the "Upper Nevada Limestone" and Three Forks Formation; the third comes from the Famennian Aplington Formation of Iowa. *Crinisarina reticulata* is from the Rhodes Canyon Formation, not the Percha as claimed by Stainbrook. *Crinisarina prouti* is from Early Mississippian rocks. All except *C. devonica* have the typical compact form, but the Three Forks specimens have a somewhat wider outline and less strongly developed fold and sulcus than usual in the other species.

***Crinisarina reticulata* (Stainbrook)**

Plate 26, figures 31–51; plate 45, figures 1–15

Cleiothyridina reticulata Stainbrook, 1947, p. 326, pl. 45, figs. 31–35; Johnson, Reso, and Stephens, 1969, p. 1362, pl. 159, figs. 1–26; text-fig. 5.

Stainbrook described this species as coming from the Percha Formation a mile south of the east entrance to Rhodes Pass in the San Andres Range. The collec-

tions of the U.S. National Museum of Natural History include a fair number of specimens of this species but their provenance is the Rhodes Canyon Formation rather than the Percha, which was not identified in this range. The species is related to *Crinisarina devonica* (Raymond) from the Three Forks Formation of Montana, but differs in having a more pronounced fold and sulcus, deeper valves that give a thicker lateral profile, and more strongly reticulate ornamentation; this was discussed in some detail by Johnson, Reso, and Stephens (1969, p. 1356).

Diagnosis.—*Crinisarina* having a strong resemblance to *Athyris* M'Coy (1844) in shape and profile, strongly reticulate ornament and strong fold and sulcus.

Stratigraphic occurrence.—Rhodes Canyon Formation; Thoroughgood Formation.

Localities.—Rhodes Canyon: 509t, u; 521f, g, h, i; 523n, p, q, v; 524c, e, o, z; 526a; 528c, j; 3054q. Thoroughgood Formation: 522.

Types.—Holotype: USNM 135248. Figured Paratype: M.A.S. 1588 (=USNM 135249), primary types figured by Stainbrook (1947). Figured Hypotypes: USNM 200925, 200974, 200928, 203539a, b.

Discussion.—Four specimens from the lower foot of the Thoroughgood Formation are included here. These specimens are badly exfoliated but they have the characteristic size, form, fold and sulcus of *C. reticulata*.

Genus **COMPOSITA** Brown, 1849

Composita bellula Stainbrook

Plate 26, figures 52–66; plate 45, figures 16–32

Meristella barrisi? Kindle (not Hall, 1860a), 1909, p. 30, pl. 9, figs. 7–8a.

Dielasma coreiforme Stainbrook, 1947, p. 318, pl. 47, figs. 34–37.

Composita bellula Stainbrook, 1947, p. 325, pl. 45, figs. 15–18, 23, 24.

This species is not a *Meristella* as Kindle thought but is the earliest species of *Composita*, a long line of brachiopods that extended into the Permian. The spire of *C. bellula* is similar to that of *C. trinuclea* (Hall, 1856) of the late Mississippian but is unlike the jugum of *C. subtilita* (Hall, 1852) which is forked at the anterior. The differences seem insufficient on which to base a genus.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b, p; 507a, c, f, h, n, o, z; 509a, c; 527d, f, h; 3026, a; 3029; 3030; 3031b; 3042s.

Types.—Holotype: M.A.S. 1583A (=USNM 155799); Figured Paratype: M.A.S. 1583B (=USNM 155801). Unfigured Paratype: M.A.S. 1538B (=USNM

155800). Figured Specimens of *Meristella barrisi*? Kindle: USNM 62037a–c. Figured Hypotypes herein: USNM 201010, 201037, 201038b; 203527a, b.

Suborder **SPIRIFERIDINA** Waagen, 1883

Superfamily **CYRTIACEA** Fredericks, (1919) 1924

Family **AMBOCOELIIDAE** George, 1931

Genus **AMBOCOELIA** Hall, 1860a

Ambocoelia capillata new species

Plate 26, figures 19–24

Two specimens of *Ambocoelia* were taken from the Percha Formation (Box Member) at localities 509b and 3029. The ventral valve is moderately convex in lateral profile and narrowly domed in anterior view. A narrow sulcus originates at the beak and extends to the anterior margin. An indistinct groove occurs on each flank and gives the appearance of the sulcus being bounded by two strong costae. The interarea is fairly long and strongly curved. The delthyrium is open.

The dorsal valve is flatly convex in both profiles and is marked medially by a broad sulcus corresponding to the two costae of the ventral valve. The median part of the sulcus is occupied by a broad costa opposing the median sulcus of the ventral valve. This arrangement produces a sulcificate anterior commissure.

The surface of both valves is covered by very fine capillae. No features of the interior could be determined.

Measurements (in mm).—USNM 201136 (Holotype): length 5.0, dorsal valve length 4.1, width 4.8, thickness 3.8.

Diagnosis.—Small *Ambocoelia* marked by fine capillae.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—509b; 3029.

Types.—Holotype: USNM 201136.

Discussion.—This species is small for the genus and differs from described species by the presence on it of fine capillae.

Ambocoelia species 1

Plate 26, figures 7–18

About normal size for genus, longer than wide, sub-pentagonal in outline with hinge wider than valves at middle; sides rounded gently and sloping gently medially; cardinal extremities rounded; anterior margin narrowly rounded; posterolateral margins forming an angle of 85°. Anterior commissure faintly sulcate. Interarea short, curved and apsacline. Delthyrium

bounded by narrow, oblique deltidial plates. Surface smooth.

Ventral valve strongly convex in lateral profile and narrowly domed in anterior profile; flanks slightly convex and steep. Umbonal and median regions strongly swollen; median region marked by a narrow sulcus extending from umbo to anterior margin.

Dorsal valve gently but unevenly convex, most convex in the posterior third; anterior profile forming a flat triangle. Anterior margin deflected in a dorsal direction to form a rim around the anterior and sides, the ventral valve fitting over the deflected surface.

Interior not known.

Measurements (in mm).—USNM 201073a: length 8.8, dorsal valve length 7.0, hinge width 7.3, midwidth 8.0, thickness 5.8.

Diagnosis.—Medium-sized, elongate *Ambocoelia* having a narrow shallow sulcus on the ventral valve, inwardly tapering sides and fairly wide hinge.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506i; 526k; 529i.

Types.—Figured Specimens: USNM 201073a, b.

Discussion.—These are the only specimens of *Ambocoelia* taken from the Sly Gap Formation. They differ in important respects from *Ambocoelia* sp. 2 in being smaller, with more prominent lateral shoulders, less rounded sides, and less anteriorly depressed dorsal valve. These specimens suggest *A. umbonata* (Conrad, 1842) from the Hamilton Group of New York, but they are smaller than a well-formed adult of the latter species, have less angular sides, a more convex dorsal valve and less of a marginal depression in the dorsal valve.

Ambocoelia species 2

Plate 26, figures 25–30

About normal size for genus, subpentagonal in outline; length and width nearly equal; hinge slightly narrower than maximum width, which is just anterior to hinge. Sides moderately rounded and sloping gently medially; anterior margin narrowly rounded; anterior commissure broadly sulcate; posterolateral margins forming an angle of 83°; interarea short and strongly curved, apsacline. Beak strongly incurved. Surface smooth.

Ventral valve gently convex in lateral profile, broadly domed in anterior profile, which has short, moderately steep sides. Umbonal and median regions swollen; median region from beak to anterior margin marked by narrow, shallow sulcus.

Dorsal valve, in lateral profile, with posterior half gently convex but anterior half gently concave; anterior profile broadly but very gently convex; median

region moderately swollen; anterior margin fairly strongly deflected in a dorsad direction, margin forming rim around concave anterior part; median region marked by shallow, narrow sulcus extending from midvalve to anterior margin.

Interior unknown.

Measurements (in mm).—USNM 201074: length 9.7, dorsal valve length 7.3, hinge width 8.6, maximum width 9.8, thickness 5.7.

Diagnosis.—Medium-sized *Ambocoelia* with moderately deep ventral valve, short strongly curved interarea, and anteriorly strongly concave dorsal valve.

Stratigraphic occurrence.—Contadero Formation.

Localities.—509o, t; 521j; 524o; 526g; 3054k.

Types.—Figured Specimen: USNM 201074.

Discussion.—This species is abundant in the upper part of the Contadero Formation, in places forming a coquina consisting mostly of ventral valves. It is suggestive of *Ambocoelia gregaria* Hall (1860a) but appears to be wider and lacks the fairly strong ventral median sulcus of the New York Chemung species. It differs from *A. umbonata* (Conrad, 1842) of the New York Middle Devonian, a widely identified species, in having a more rounded outline with rounded cardinal extremities, a more convex dorsal valve and smaller size. This Contadero *Ambocoelia* is probably a new species but, though it is common in places, our material is inadequate in quality and quantity to provide a basis for a formal species description.

Ambocoelia species 3

Several poor specimens of a large *Ambocoelia* were taken from the basal foot of the Thoroughgood Formation at locality 522. The species is longer than wide, with a long interarea and moderately incurved beak. The sulcus of the ventral valve is fairly strongly developed. The dorsal valve is swollen posteriorly but shallowly concave at the anterior and has a reflected margin.

Measurements of largest specimen (in mm).—USNM 203509a: length 11.5, dorsal valve length 8.0, width 10.0, thickness 6.7.

Types.—Described Specimens: USNM 203509a–g.

Ambocoelia species 4

Ambocoelia is abundant in some beds of the Oñate Formation as at Nackaye Mine above the Derry Hills and in San Andres Canyon. Unfortunately, the specimens are invariably crushed and none suitable for description or illustration was found. An average specimen measures about 10 mm in width and 7.5 mm in length. Other features are in accordance with the

smooth shell and the anteriorly situated growth lamellae usually seen in *Ambocoelia*.

Localities.—522m, q; 523e; 524i, p, q, x; 526b; 529i, l, m, w.

Types.—Measured Specimen: USNM 252627.

Genus EMANUELLA Grabau, 1925

Emanuella species

Plate 26, figures 1–6

About medium-sized for genus, slightly wider than long, subcircular in outline. Maximum width just anterior to hinge; sides and anterior margin strongly rounded; posterolateral margins forming angle of 106° ; anterior commissure rectimarginate. Interarea short, apsacline; beak strongly incurved, only moderately protruding beyond posterior margin. Surface smooth. Ventral valve fairly strongly convex in lateral profile with maximum convexity at midvalve; anterior profile somewhat narrowly domed and having flattened, steeply sloping flanks. Umbonal and median regions strongly swollen.

Dorsal valve moderately convex in lateral profile and moderately and broadly convex in anterior profile. Umbonal and median regions swollen but anterior part somewhat flattened. Dorsal valve interior with short median septum.

Measurements (in mm).—USNM 203559: length 10.0, dorsal valve length 8.8, hinge width 5.5, maximum width 10.3, thickness 6.4.

Diagnosis.—Nearly circular *Emanuella* having strongly incurved beak and interarea, and both valves smooth.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522n; 524i, q, x; 526b; 528i; Lost Canyon, Hermosa, New Mexico (R. Flower, collector).

Types.—Figured Specimen: USNM 203559.

Discussion.—Only one good specimen of this species was taken and it is assigned to *Emanuella* rather than to *Crurithyris* George (1931) because of its narrow hinge, strongly rounded sides, smoothly convex dorsal valve and strongly incurved beak. It suggests *E. subumbona* (Hall, 1857) from the top of the Hamilton and "*E.*" *meristoides* (Meek, 1868) from the Middle Devonian of the lower MacKenzie Valley, Canada, but is smaller and more transversely oval than either of these species.

Genus ECHINOCOELIA Cooper and Williams, 1935

Echinocoelia pretiosa new species

Plate 27, figures 20–29

About medium-sized for genus, length and width

nearly equal; subpentagonal in outline, sides well-rounded; anterior strongly rounded; cardinal extremities narrowly rounded; hinge narrower than maximum width, which is at about midvalve; posterolateral margins forming angle of 87° . Anterior commissure rectimarginate. Beak fairly long and moderately protuberant beyond the posterior margin. Interarea long and moderately curved, strongly apsacline. Surface marked by fine concentric lines bearing fine spines, three or four concentric lines to one mm on the body of ventral valve.

Ventral valve moderately convex in lateral profile and narrowly rounded at the umbo where the beak is moderately incurved; anterior profile narrowly domed with steeply sloping sides. Umbonal and median regions strongly swollen. Flanks flattened but steep.

Dorsal valve very gently convex in lateral profile but nearly flat in anterior profile. Umbonal region slightly swollen; posterolateral areas gently concave. Antero-median region flattened.

Ventral valve with thick dental ridges and long narrow muscle field divided medially by a low myophragm. Dorsal valve interior having a moderately large cardinal process, rounded and without shaft. Socket ridges strong and elevated, bounding deep sockets. Crural bases triangular and descending close to the inner surface of the valve; descending lamellae of the spire closely following the inside of the dorsal valve; complete spire not seen.

Measurements (in mm).—USNM 201072 (Holotype): length 8.8, dorsal valve length 7.3, hinge width 5.5, maximum width 8.7, thickness 5.5.

Diagnosis.—*Echinocoelia* of intermediate size having a fairly long interarea, moderately incurved beak, and three or four concentric lines to the mm on the body of the ventral valve.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522i, n; 523b, f, s; 524i.

Types.—Holotype: USNM 201072. Figured Paratypes: USNM 201065, 201156.

Discussion.—This species is much smaller than *Echinocoelia ambocoelioides* Cooper and Williams (1935) and *E. incurva* Cooper and Williams (1935). These two species also have longer interareas and less incurved beaks than the New Mexico species. *Echinocoelia denayensis* Johnson (1966) is similar in size, but its interarea is much longer and the beak less incurved than that of *E. pretiosa*. Moreover, the New Mexico species has a narrower hinge and more rounded sides than those of the Nevada species.

Echinocoelia pretiosa is a very rare species, only seven specimens having been found in the Oñate Formation.

Superfamily SPIRIFERACEA W. King, 1846

Family MUCROSPIRIFERIDAE Boucot 1959

Genus ELEUTHEROKOMMA Crickmay, 1950

***Eleutherokomma extensa* new species**

Plate 27, figures 30–35

About medium-sized for genus, greatly extended laterally with sharply pointed extremities. Width about three times the length. Anterior commissure uniplicate. Beak moderately extended; interarea fairly long, curved, apsacline. Surface marked by 14 costae on each side of the fold and sulcus; costae covered by crowded, thin, concentric lamellae, four to one mm. Surface of lamellae in sulcus and flanks marked by fine radial capillae.

Ventral valve moderately convex in both profiles; sulcus originating at beak, deep and narrow, occupying about one-seventh of width. Sulcus narrowly V-shaped and forming a short, sharp tongue anteriorly. Flanks gently convex near the sulcus but becoming gently concave laterally.

Dorsal valve moderately convex in lateral profile; broadly convex medially in anterior profile with flanks becoming gently concave laterally. Fold originating at beak, rather narrow throughout its length, forming a V-shaped arch anteriorly. Fold barely perceptibly set off from flanks.

Ventral valve interior with strong dental plates.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	mid- width	thick- ness
USNM 200876a (Holotype; loc. 3052a)	10.6	8.2	29.0	19.3	7.4

Diagnosis.—*Eleutherokomma* having width three times its length.

Stratigraphic occurrence.—Oñate Formation.

Locality.—3052a.

Types.—Holotype: USNM 200876a. Unfigured Paratype: USNM 200876b.

Comparison.—This species has a strongly extended hinge like that of *E. reidfordi* Crickmay (1950), but the length is much less in relation to width than in that species. Furthermore, *E. reidfordi* bears a costa in the sulcus but the sulcus of *E. extensa* is without a costa in the sulcus and the fold does not have a corresponding median depression as in *E. reidfordi*. The paratype was partially sectioned and exhibits strong dental plates.

***Eleutherokomma* species**

Plate 39, figures 45–47

About usual size for genus, wider than long; widest along the hinge; cardinal extremities acutely pointed. Sides obliquely rounded; anterior margin broadly rounded. Valves unequally convex, the dorsal valve having the greater convexity. Interarea long, orthocline and fairly strongly curved. Fold and sulcus without costae; flanks marked by 12 to 15 (?) costae, those of the extremities fine and indistinct. Entire surface marked by unevenly distributed concentric lamellae that have faint, fine capillae on their margins.

Ventral valve moderately convex in lateral profile but broadly and fairly strongly convex in anterior profile. Sulcus beginning at the beak, widening gradually anteriorly to occupy about one-fourth the valve width. Tongue short. Flanks gently convex; flanks at ears concave.

Dorsal valve more convex than the ventral valve in lateral profile; broadly domed in anterior profile; flanks flattened and extremities less well demarcated than those of the ventral valve. Fold originating at the beak low and narrow, forming a fairly strongly uniplicate anterior commissure.

Measurements (in mm).—USNM 203560a: length 14.0, hinge-width 21.0+, dorsal valve length 11.7, mid-width 19.4, thickness 11.5.

Diagnosis.—*Eleutherokomma* with strongly convex dorsal valve, long orthocline interarea, and irregularly lamellose ornamentation.

Stratigraphic occurrence.—Sly Gap Formation? (uppermost sandstone).

Locality.—522s.

Types.—Figured Specimens: USNM 203560a, b, c.

Discussion.—This species is represented by two ventral valves and a complete but very poorly preserved individual. The ventral valves are impressions, one of the exterior only, the other of both interior and exterior. The fact that the interior bears no median septum separates this species from *Tylothyris* North (1920). The exteriors are not well preserved but very fine capillae can be detected with careful study, thus helping to confirm the assignment to *Eleutherokomma*. Most species of *Eleutherokomma* are strongly mucronate and thus are not to be identified with the form under discussion. *Eleutherokomma aechmorphia* Crickmay (1963), from the Waterways Formation, is perhaps the closest described species but it has more closely crowded concentric lamellae, less convex valves and a long, nearly procline interarea. The Caballos Mountains form appears to be a new one, but the material is not adequate to establish a species.

Genus **MUCROSPIRIFER** Grabau, 1931**Mucrospirifer parvus** new species

Plate 27, figures 1–19

Small for genus, semielliptical in outline; hinge about equal to the maximum width, which is located at about midvalve; cardinal extremities nearly a right angle. Sides slightly oblique and slightly rounded; anterior margin broadly rounded; anterior commissure unipligate. Interarea long, slightly curved and with beak incurved, apsacline. Delthyrium wide, open. Surface costate, nine or ten costae on each flank; entire surface covered by closely crowded imbricating lamellae without any micro-ornament.

Ventral valve unevenly convex in lateral profile, the posterior part having the greater convexity; anterior profile forming a broad curve, indented medially, with lateral slopes gently convex and moderately steep. Sulcus originating at beak, widening anteriorly to occupy about one-third valve width at midvalve; sulcus shallow and flat-floored and extending onto a short, abruptly truncated tongue.

Dorsal valve fairly evenly and gently convex in lateral profile but broadly and fairly strongly convex in anterior profile. Fold beginning at the beak, elevating slightly anteriorly but never strongly elevated above the convex flanks; fold flat-topped but with an indistinct median depression.

Interior not known except for lack of myophragm in ventral valve.

Measurements (in mm).—

	length (L)	dorsal valve length	hinge width	mid- width (W)	thick- ness	L/W ratio
USNM 203541 (Holotype; loc. 528k)	12.4	10.5	16.6	17.0	10.3	0.65
USNM 201046a (loc. 526c)	9.6	8.5	14.4	13.8	7.3	0.69
USNM 201104 (loc. 524j)	15.5	14.2	17.0	20.0	12.3	0.77

Diagnosis.—Small, non-extended *Mucrospirifer* having a flat fold and a sulcus with flat floor and truncated tongue.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522f, g, i; 523e, i, u, z; 524a, g, j, l, u; 526c, h; 528k; 529j, o.

Types.—Holotype: USNM 203541. Figured Paratypes: USNM 201046a, 201104. Unfigured Paratypes: USNM 201046b, c.

Discussion.—Externally, this species is very similar to some specimens identified herein as *Tylothyris* North (1920), but it differs from them in not being laterally

extended and in not having a myophragm in the muscle field of the ventral valve.

Mucrospirifer parvus n. sp. suggests *Mucrospirifer consobrinus* (d'Orbigny, 1850) from the Hamilton Group of New York, but that species is larger and has more laterally extended ears than the New Mexico species. A number of small mucrospiriferids in the Middle Devonian of the Hamilton and Traverse groups are suggestive of *M. parvus*, but they have not yet been described.

This is a rare species in the Oñate Formation.

Mucrospirifer? cf. *M.?* **sculptilis** (Hall)

A few specimens of a coarsely plicated mucronate spiriferoid are suggestive of *Mucrospirifer?* *sculptilis* (Hall, 1843), which is common in the Middle Devonian of New York. The specimens are so badly worn that they do not show well the strong concentric, zigzag lamellae characteristic of the species. The specimens are found associated with *Tropidoleptus platys* n. sp. in the Oñate Formation at localities 528t, 529g, 3023b, in Johnson Park Canyon.

Types.—Mentioned Specimens: USNM 201185a–d.

Genus **TYLOTHYRIS** North, 1920**Tylothyris compacta** new species

Plate 27, figures 57–67; plate 39, figures 23–26

About medium size for genus, subrectangular in outline, hinge forming the widest part but not extended beyond small points; sides rounded and anterior margin broadly truncated. Anterior commissure strongly unipligate. Surface of both valves costate, nine costae to a side in adult; whole surface covered by closely crowded, nonspinose, concentric lamellae, about two to a mm near midvalve. Lamellae more closely crowded at the anterior.

Ventral valve slightly deeper than dorsal valve, fairly strongly convex in lateral profile and broadly convex in anterior profile, dome having a deep excavation at middle representing sulcus. Flanks convex and steep. Interarea short, curved and apsacline. Sulcus beginning at beak, wide and deep, forming a broad V and occupying about half shell width. Each costa bounding sulcus elevated slightly over flanks. Sulcus, in an occasional specimen, bearing an indistinct costa. Tongue forming sharp angle.

Dorsal valve unevenly convex in lateral profile, posterior half having fair curvature but anterior half only slightly convex. Anterior profile broad triangle. Fold originating at beak, moderately elevated above flanks and somewhat narrowly rounded, bearing a slight median depression. Flanks flat in profile but rounded in longitudinal direction.

Ventral valve interior with greatly thickened delthyrial region and short but deeply entrenched diductor scars; myophragm short and slender.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 200986a (Holotype; loc. 522)	16.6	14.0	—	23.6	13.2
USNM 200986b (loc. 522)	12.1	10.2	16.4	15.7	9.7

Diagnosis.—Medium sized *Tylothyris* having a wide sulcus, nine costae on a side, short interarea, and greatly thickened ventral interior.

Stratigraphic occurrence.—Thoroughgood Formation and Contadero Formation.

Localities.—Thoroughgood: 522. Contadero: 522a, 524oa.

Types.—Holotype: USNM 200986a. Figured Paratypes: USNM 200986b, c; 201032.

Discussion.—This species is larger and less laterally extended than any other species of *Tylothyris* from the New Mexico Upper Devonian. It suggests some forms of *T. mesacostalis* (Hall, 1843) from the Chemung Group of New York, but the eastern specimens have a stronger costa in the sulcus, with a deeper depression on the fold, and the myophragm of the interior is much stronger than that of the New Mexico species.

***Tylothyris novamexicana* Stainbrook**

Plate 27, figures 36–50; plate 28, figures 25–32

Tylothyris novamexicana Stainbrook, 1947, p. 323, pl. 47, figs. 31–33.

Small, wider than long, with hinge drawn out to long points. Sides slightly convex and sloping medially. Interarea moderately long, curved, apsacline. Anterior commissure strongly uniplicate. Surface of both valves marked by costae, eight to 13 on a side depending on valve width; costae covered by closely crowded, smooth, non-spinose, lamellae—three or four to the mm.

Ventral valve strongly convex in lateral profile but forming a broad dome in anterior profile with sides flattened and dipping steeply away from a deep median indentation formed by the sulcus, which originates at beak. Sulcus deep and subangular, forming long acute tongue at anterior.

Dorsal valve about equal in depth to the ventral valve and fairly strongly convex in lateral profile; anterior view broadly triangular with the fold forming subacute apex and sides descending steeply. Fold originating at beak, elevating anteriorly above flanks, narrowly rounded to subangular.

Ventral valve interior with strong muscle myophragm. Cardinal process comb-like.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 135263	8.8	6.6	12.8	10.0	6.4
USNM 201107 (loc. 523q)	11.2	8.8	17.4	14.1	11.0
USNM 201060 (loc. 521g)	9.2	7.8	17.0	12.7	7.8
USNM 203511 (loc. 509u)	9.6	8.4	16.2	13.8	8.5

Diagnosis.—Small *Tylothyris* having subangular fold and sulcus.

Stratigraphic occurrence.—Contadero and Rhodes Canyon formations.

Localities.—Contadero: 509u; 523q. Rhodes Canyon: 521g; 523v; 524z; 528c, j.

Types.—Figured Hypotypes: USNM 201060, 201017, 203545a.

Discussion.—This species is most like *T. sulcocos-tata* n. sp. in size and general appearance but it has a deeper sulcus with more sharply angular tongue, and a narrowly rounded fold that is not medially grooved.

***Tylothyris sulcocos-tata* new species**

Plate 27, figures 51–56; plate 28, figures 1–24; plate 39, figures 48–51; plate 44, figures 21–26

Small, semielliptical in outline; inequivalved, ventral valve being deeper. Hinge forming widest part and often drawn into sharp angles or blunt points. Sides sloping strongly medially; anterior subtruncate. Anterior commissure strongly uniplicate. Surface costate, costae varying from eight to eleven on each side; costae covered by fine, concentric lamellae from three to five in one mm near midvalve.

Ventral valve moderately convex in lateral profile but broadly triangular in anterior profile, sides flat and moderately steep, apex of triangle truncated or narrowly and gently concave where the sulcus is located. Interarea fairly long, slightly to moderately curved and apsacline. Delthyrium fairly wide and open. Sulcus originating at beak, widening rapidly anteriorly to occupy about one-third to a quarter valve width; sulcus shallow and occupied medially by a low costa of variable strength. Costae on each side of sulcus stronger than those of flanks and slightly elevated above flanks.

Dorsal valve gently convex in lateral profile; anterior profile a broad dome slightly elevated medially by the flatly rounded fold, the sides of the dome slightly convex and moderately sloping to the extremities. Fold originating at beak, flatly convex and marked medially by low narrow depression that extends from beak to

anterior margin and matches the costa of the ventral sulcus.

Ventral valve interior with strong muscle myophragm.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 201020 (loc. 521d)	9.4	8.8	16.4+	14.0	7.9
USNM 201067a (loc. 506j)	8.4	8.3	17.4+	13.7	8.3
USNM 201067b (loc. 506j)	8.7	8.2	16.7+	14.2	8.0
USNM 201067c (loc. 506j)	8.9	8.0	17.1+	14.1	7.5
USNM 201067d (loc. 506j)	8.6	8.2	14.7?	13.0	6.7
USNM 201019 (Holotype; loc. 509z)	10.0	9.6	17.3+	14.8	8.8
USNM 201016 (loc. 509p)	11.2	10.0	19.2*	14.6	10.4
USNM 201043 (loc. 509r)	9.8	8.4	16.0*	12.2	7.3

Diagnosis.—Small *Tylothyris* with wide hinge, costa in the sulcus and depression on the fold, and with eight to eleven costae on a side.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506j, y; 509f, i, p, r, s, x, z; 521d, e, k, m; 522x; 523m; 524m, w; 526e; 3054c.

Types.—Holotype: USNM 201019. Figured Paratypes: USNM 201016, 201020, 201043, 201067c. Unfigured Paratypes: USNM 201033, 201067a, b, d.

Discussion.—This species is similar to *T. novamexicana* Stainbrook (1947) in size but is readily distinguished by its flatter fold, with shallow median groove, and the corresponding sulcus on the ventral valve, which bears a median costa.

Tylothyris species 1 Plate 29, figures 29–41

This species is larger than *T. novamexicana* Stainbrook (1947) and has a strong costa in the sulcus of the ventral valve and a corresponding groove along the center of the fold of the dorsal valve. It is also larger and wider than *T. sulcocostata* n. sp., the fold is narrow and provided with a strong groove, and the sulcus bears a much stronger costa than that of the Sly Gap species. Although this species approaches *T. compacta* n. sp. in size it is differently proportioned, not being so chunky and in being more laterally extended. *Tylothyris* sp. 1 occurs in the silty limestone of the Contadero Formation. It has proved impossible, with the material at hand, to produce enough clean specimens to give good descriptive material. Its de-

scription must therefore await discovery of better specimens.

Diagnosis.—Wide-hinged, fairly large *Tylothyris* having a narrow fold and sulcus and a strong median costa and groove.

Stratigraphic occurrence.—Contadero Formation.

Localities.—509t; 521f, j; 523n, p; 524o, t; 526g; 528q.

Types.—Figured Specimens: USNM 201047, 201048, 201049.

Genus *STROPHOPLEURA* Stainbrook, 1947

Strophopleura notabilis (Kindle)

Plate 29, figures 1–21

Spirifer bimesialis Girty (not Hall, 1858), 1900, p. 55.

Spirifer notabilis Kindle, 1909, p. 26, pl. 7, figs. 3–6c.

Strophopleura notabilis (Kindle) Stainbrook, 1947, p. 324, pl. 44, figs. 17–20.

This is a fairly rare species and it is difficult to obtain good specimens with the mucronate points intact. The illustrations are introduced to better the understanding of this genus.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, a, b, p, q; 507b, d, h, k, m, o; 509a, b, e; 527a, d, e, f, g, j, l, p; USGS (Kirk) 508, 509; 3026, a; 3034; 3042, s.

Types.—Hypotype: USNM 62025. Figured Hypotypes: M.A.S. 1586A, B (=USNM 155804). Figured Hypotypes, herein: USNM 200847, 200848a, b, 201146, 201147a, 201148a, 201149a.

Family *SPINOCYRTHIDAE* Ivanova, 1959

Genus *ORTHOSPIRIFER* Pitrat, 1975

Orthospirifer species

Plate 29, figures 22–28

Large, wider than long, hinge forming the widest part in young specimens; cardinal extremities acute and sharply pointed in young but rounded in adult shells; sides rounded and sloping obliquely medially; anterior commissure uniplicate. Interarea moderately long, curved, apsacline; delthyrium open. Surface costate, fold and sulcus without costae; flanks marked by 21 costae on a large specimen; micro-ornament consisting of fine radial capillae on fold and sulcus but not seen elsewhere on valves.

Ventral valve gently convex in lateral profile, broadly and moderately convex in anterior view. Sulcus originating at beak, only moderately deep anteriorly and occupying about one-fourth the valve width. Flanks gently convex. Tongue short and broadly rounded.

Dorsal valve moderately convex in lateral profile with maximum convexity in posterior part; anterior

profile broadly but gently convex. Fold originating at beak, very gently convex and scarcely elevated above flanks at anterior. Flanks moderately convex, more so than those of the ventral valve.

Ventral valve interior with strong, divergent dental plates and a short apical plate. Details of the interior of the dorsal valve not seen.

Measurements (in mm).

	length (L)	dorsal valve length	hinge width	maxi- mum width (W)	thick- ness	L/W ratio
USNM 201128a (loc. 3023c)	25.5	—	34.8	37.0	7.6?	0.70
USNM 201128b (loc. 3023c)	37.8	37.0	40.0	59.2	11.0	0.66

Diagnosis.—*Orthospirifer* apparently having flanks devoid of micro-ornament.

Stratigraphic occurrence.—Oñate Formation.

Locality.—526z; 3023c.

Types.—Figured Specimens: USNM 201128a–e.

Discussion.—The specimens on which this species is based are poor. Most of them are exfoliated, but where the preservation of the costae on the flanks seems well preserved, no capillae were observed on them. This is the only example among the many species of *Orthospirifer* in the National Collections on which radial lines do not appear on the costae of the flanks. Because some fairly worn specimens of other species of *Orthospirifer* exhibit traces of the lines, it is probable that the Oñate species had them and better specimens would reveal their presence.

Genus SPINOCYRTIA Fredericks, 1916

Spinocyrtia? species

Three specimens, preserved in a chert replete with *Tentaculites* Schlotheim (1820), are referred with some doubt to this genus. The specimens are partially silicified and the single dorsal valve is an inner impression. The characteristic granules of *Spinocyrtia* were not detected but the ventral valves have the nearly orthocline, curved interarea and subangular sulcus often seen in this genus. The costae are closely crowded, low and rounded, about 13 on the flanks of the ventral valve. The fold of the dorsal valve is narrowly rounded and evenly, but moderately, elevated above the rounded flanks. The specimens measure about 20 mm long and 30 mm wide.

Stratigraphic occurrence.—Oñate Formation.

Locality.—529g.

Types.—Mentioned Specimens: USNM 200985a–c.

ACUTORIA new genus

[Latin *acutus* = acute, sharp]

Spiriferoid, large, transverse; sides rounded; hinge narrower than midwidth; concavo-convex, ventral valve with concave flanks and deep angular sulcus; dorsal valve swollen, with convex flanks and high, angular fold. Beak strongly obtuse. Costae wide, flat, separated by narrow striations. Entire surface covered by fine radial capillae, strongest on fold and in sulcus.

Ventral valve with open delthyrium and horizontal apical plate between long divergent dental lamellae. Dorsal valve with short median septum buttressing cardinal process and cardinalia.

Type species.—*Acutoria angulata* n. sp.

Diagnosis.—Like *Orthospirifer* internally but with concave ventral valve, acute fold and broad flat costae.

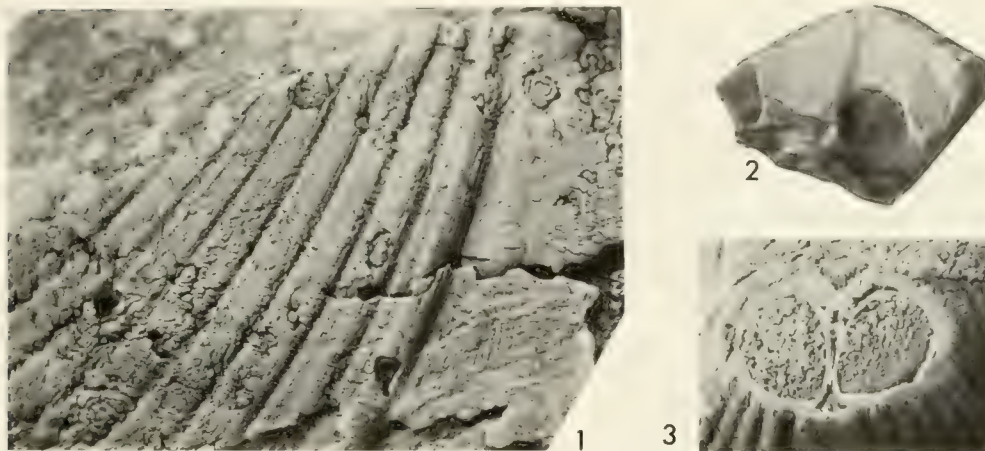
Comparison.—This brachiopod was originally mistaken for *Paraspirifer* Wedekind (1926) and identified with *P. acuminatus* (Conrad, 1839) of the Onondaga in the eastern United States and Canada (Stevenson, 1943). It differs from *Paraspirifer* in the concavity of the ventral valve and in its fine radial ornament. The costate surface of *Paraspirifer* is covered by close rows of concentric lines bearing minute spines; the fine ornament of *Acutoria* consists of fine longitudinal capillae. Distinction from *Orthospirifer* is based on the flat costae with the very fine grooves separating them, the concave ventral valve, the acute dorsal fold and the short median septum. The fold of *Orthospirifer* is invariably broadly rounded and low, and its costae are more or less narrowly rounded.

Acutoria angulata new species

Plate 28, figures 33–42; Text-figure 9

Large, subrectangular in outline; hinge narrower than maximum width which is at midvalve. Sides rounded, postero-lateral extremities forming angle of 126°; anterior margin broadly emarginate. Anterior commissure angularly uniplicate. Ventral valve interarea long, plane, apsacline. Surface with both macro- and micro-ornament; macro-ornament on flanks consisting of broad, flat costae separated by narrow interspaces, eleven or twelve costae on each side; fold and sulcus non-costate; micro-ornament consisting of fine, elevated, radial lines (capillae) covering entire surface of both valves.

Ventral valve unevenly convex along center line, umbonal region flatly convex, anterior and middle regions strongly concave; anterior profile broadly, deeply concave, forming broad V. Sulcus originating just anterior to beak, deepening and widening rapidly to



Text-figure 9.—*Acutoria angulata* n. sp. 1. Part of the dorsal valve exterior showing radial capillae on the costae and fold, $\times 5$, paratype USNM 201127f; 2. Apical part of the ventral valve interarea, showing the apical plate, $\times 2$, paratype USNM 201127g; 3. Beak of the dorsal valve showing silicified median septum, buttress plates and cardinal process, $\times 4$, paratype USNM 201127i. Oñate Formation, locality 526z.

occupy nearly half maximum width. Sulcus V-shaped, forming angular tongue; flanks flattened to gently concave.

Dorsal valve very deep; gently convex in lateral profile but forming a high, pointed dome in anterior profile; flanks slightly convex, steep. Fold originating at beak, elevating anteriorly, steep-sided and fairly strongly elevated above flanks.

Ventral valve interior with broad and thick apical plate; strong dental plates. Dorsal valve interior with short median septum just anterior of umbo.

Measurements (in mm).—

	dorsal valve length	length	hinge width	mid- width	thick- ness	height
USNM 201127d (Holotype; loc. 526z)	36.4	—	42.0?	52.0	—	4.0?
USNM 201127a (loc. 526z)	35.0	—	39.5	42.4	—	3.2?
USNM 201127b (loc. 526z)	—	37.2	31.8	48.0	—	26.0
USNM 201127f (loc. 526z)	—	36.4	38.0?	47.0?	—	16.7

Diagnosis.—Large *Acutoria* having concave ventral valve with sharply angular fold and sulcus; entire surface radially capillate.

Stratigraphic occurrence.—Oñate Formation.

Localities.—526z; 528t; 3023c.

Types.—Holotype: USNM 201127d. Figured Paratypes: USNM 201127a–c, e, f, g, i.

Discussion.—The most similar species to this one are: the American *Paraspirifer acuminatus* (Conrad, 1839), *P. bownockeri* (Stewart, 1927), and the German *P. cultrijugatus* (Roemer, 1844); but all of these differ in their micro-ornament from that of *Acutoria angu-*

lata n. sp. The micro-ornament of *Paraspirifer* Wedekind (1926) consists of crowded concentric lines bearing minute spines, whereas that of the New Mexico species has fine radial lines only. *Acutoria angulata* differs in another respect in that the flanks of the ventral valve are concave or flat; they are not convex as in the species of *Paraspirifer* mentioned above.

Acutoria angulata also suggests *Orthospirifer mesastrialis* (Hall, 1843), both being liberally adorned with fine radial lines; however, the New York species has a rounded fold and sulcus, is much wider, and its ventral valve is not deeply concave.

Some of the specimens illustrated here were used by Stevenson (1943, p. 222) in his announcement of an "Onondagan equivalent in New Mexico", based on the identification of "*Paraspirifer* cf. *acuminatus*". The specimens now prove not to be *Paraspirifer* and their occurrence is in the Oñate Formation, as indicated by evidence discussed elsewhere in this paper, a much younger formation than the Onondaga.

Genus **ACUTATHECA** Stainbrook, 1945

***Acutatheca prolifica* new species**

Plate 36, figures 1–26; plate 44, figures 11–20

Not Acutatheca propria = *A. cf. propria* Stainbrook, 1948; p. 777, pl. 2, figs. 21, 22.

Small, strongly inequivalved; pedicle valve semi-pyramidal in profile, dorsal valve subpentagonal in outline; sides sloping medially; hinge slightly less wide than the greatest width, which is near the posterior of the dorsal valve; cardinal extremities narrowly rounded; anterior commissure strongly uniplicate. Ventral interarea long (in direction of valve length), gently curved, steeply apsacline to catacline. Delthyrium long and narrow, partially closed by apical plate (pseudo-

deltidium?) that occupies the posterior third to half of delthyrium; delthyrial edges marked by narrow plates oblique to surface of interarea. Surface of both valves costate, costae broadly rounded, two to four on a side, and separated by spaces about equal to width of costae. Entire surface covered by fine radial capillae, seen only in unusually well preserved specimens.

Ventral valve triangular in lateral profile with ventral valve gently convex; anterior profile narrowly domed. Umbonal region narrow; sulcus originating near beak and widening anteriorly to occupy about 40 percent of maximum width of valve. Flanks flattened in profile, depressed below two strong costae bounding sulcus.

Dorsal valve fairly strongly convex in lateral profile but having the umbonal region narrowly curved; anterior profile a strongly domed curve having steeply dipping sides. Flanks gently swollen. Narrow fold beginning at the beak, widening gradually anteriorly, somewhat flat-topped, and with a median depression throughout its length. Flanks depressed well below the fold and separated by deep bounding grooves.

Ventral valve interior with two strong, slightly divergent dental plates extending for one-sixth to one-fifth the surface length of the ventral valve. Dorsal valve interior with two convergent plates that form a small chamber with the median ridge.

Measurements (in mm).—

	length	dorsal valve length	hinge width	maxi- mum width	thick- ness	apical angle
USNM 201105a (loc. 506c)	12.4	12.2	15.9	17.9	12.3	96°
USNM 201105c (loc. 506c)	12.5	11.9	13.0	16.6	11.7	92°
USNM 201105d (loc. 506c)	10.7	11.2	11.4	14.2	10.0	96°
USNM 201105b (loc. 506c)	18.0	15.7	17.0	20.3	14.5	94°
USNM 201001a (loc. 506i)	12.4	12.0	15.5?	17.9	13.9	87°
USNM 203524 (loc. 509g)	10.7	10.3	10.7	14.4	10.6	97°
USNM 200958 (loc. 509h)	12.6	12.7	15.5?	17.3	13.2	92°
USNM 201008 (loc. 509w)	13.2	12.8	16.0	19.4	13.8	92°

Diagnosis.—Large, strongly costate *Acutatheca* having a median depression in the fold.

Stratigraphic occurrence.—Sly Gap Formation (upper part).

Localities.—506c, i, v; 509f, g, h, i, j, k, l, m, n, v, w; 521l, o, p, r; 526k, 3045b.

Types.—Holotype: USNM 201050a. Figured Paratypes: USNM 200958, 201001a, 201008, 201132b,

201142. Unfigured Paratypes: USNM 201001b, 201050b–d, 201132a.

Discussion.—Although Stainbrook assigned specimens from Alamo Canyon to his species *A. propria* in his description of the Independence Shale fauna (1945, p. 56), he was not so positive in his paper on the Sly Gap fauna (1948, p. 777, pl. 2, figs. 29–32). In the latter paper, the species here described was referred to as *Acutatheca* cf. *propria* in the plate legend but as *A. propria* in the text. The Independence shale specimen figured in 1945 (pl. 1, figs. 39–41) is a very small shell that differs considerably from the New Mexico species. The New Mexico specimens are twice the size of the Iowa species or even more than that. In addition, they are more strongly costate and have fewer costae on the lateral slopes.

The apical plate in some of the specimens is strongly convex, in some it is nearly flat, and in others it is slightly concave. Probably, the normal condition is convex but, most likely, in many specimens the apical plate has been flattened during fossilization. Many specimens exhibit lateral plates as well as the apical plate. These are located on the sides of the delthyrium, highest at the base and descending toward the apex where they fade out. They are oblique to the surface of the interarea.

Family **THOMASARIIDAE** new family

Small, hemipyramidal shells, with strong, long dental plates and thick apical plate. Brachial valve interior with vertically lamellate cardinal process and socket plates free. Surface marked by fine pustules.

The family assignment of *Thomasaria* has been in question since Stainbrook proposed the genus in 1945 and suggested ambocoeliid affinities. Pitrat (*in Williams et al.*, 1965, p. H711) did not place the genus in any known family. Because of its unusual combination of characters, we are erecting a new family which, at present, includes only the genus *Thomasaria*.

Genus **THOMASARIA** Stainbrook, 1945

Thomasaria altumbona Stainbrook

Plate 35, figures 1–3

Thomasaria altumbona Stainbrook, 1945, p. 58, pl. 4, figs. 22–30, text-fig. 2 [14].

This is a generally smaller species than the New Mexico forms referred to *Thomasaria warreni* n. sp. Specimens are illustrated to show details of the interior and interarea of the ventral valve.

Stratigraphic occurrence.—Independence Formation.

Locality.—528l, m.

Types.—Figured Hypotypes: USNM 135294a, 201066.

Thomasaria demissa new species

Plate 33, figures 55–65; plate 35, figures 4–24; plate 39, figures 35–37; plate 41, figures 27–33

Small, but about normal size for genus, usually wider than long with narrowly rounded to sharply pointed cardinal extremities. Hinge wide, greater than, equal to, or slightly less than maximum width. Sides gently curved and sloping medially; anterior narrowly truncated. Interarea long (in the direction of valve length), flat to faintly curved, catacline to procline to steeply apsacline. Delthyrium long and narrow, partially plugged by narrow plates deposited on inner sides of dental plates; also partially closed by narrow, oblique plates on margin of the delthyrium; beak sharply pointed. Anterior commissure narrowly uniplicate. Surface marked by fine concentric, radial lines each bearing a row of minute, single-barreled spines.

Ventral valve semipyramidal in lateral profile with the valve gently convex; anterior profile broadly domed. Umbonal region narrow; sulcus originating at beak, shallow throughout its length and widening anteriorly to occupy about 40 percent of the hinge width. Tongue short and flatly rounded.

Dorsal valve very gently convex in lateral profile; broadly and gently convex in anterior profile. Umbonal region moderately swollen, the swelling continued anteriorly to join the fold, which originates at about midvalve and is low and conspicuous only at anterior; flanks sloping to margins, steepest anterolaterally.

Measurements (in mm).—

	dorsal length (L)	valve length	hinge width	maxi- mum width (W)	thick- ness (T)	apical angle
USNM 200936a (loc. 521e)	11.4	11.9	17.4	17.9	13.8	91°
USNM 200936b (Holotype)	9.1	10.1	17.4	17.4	12.2	89°
USNM 201022b (loc. 509r)	9.4	10.2	17.8	17.8	11.6	106°
USNM 201022c	8.4	9.8	19.2	19.2	10.6	108°
USNM 201022a	10.0	10.5	17.5	17.5	12.3	88°
USNM 203523a (loc. 509p)	9.9	10.5	12.4	13.0	9.6	96°
USNM 200987b (loc. 509o)	9.3	10.0	13.7	14.3	8.7	97°
USNM 200987c (loc. 509o)	9.6	10.6	21.0*	21.0*	11.0	91°
USNM 200987a (loc. 509o)	10.5	11.2?	23.6*	23.6+	14.6	95°
USNM 200987d (loc. 509o)	13.3	13.2	20.0*	20.0?	14.2	93°
USNM 201157 (loc. 509o)	9.4	9.2	14.6	14.6	11.8	84°
USNM 203522a (loc. 521k)	8.7	9.7	17.8	17.8	11.3	91°
USNM 203522b	11.5	12.0	18.8*	18.7	13.7	90°

Mean L/W ratio = 0.56; Mean T/W ratio = 0.66.

Diagnosis.—Strongly catacline, usually transverse *Thomasaria* having a low fold.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506e, j, y; 509n, o, p, q, r; 521e, k, v; 522b, k; 524v; 526d; 528p; 529p; USGS (Kirk) 534.

Types.—Holotype: USNM 200936b. Figured Paratypes: USNM 200936a, 200987d, 201022b, c, 201157, 205261. Unfigured Paratypes: USNM 200987a–c, 201022a.

Discussion.—The main distinction between *Thomasaria warreni* n. sp. and *T. demissa* n. sp. is in the nature of the ventral palintrope and the length/width ratio. Most of the specimens of *T. demissa* have the palintrope usually catacline but varying to slightly apsacline or definitely procline. Variants of *T. warreni* may attain a catacline palintrope but they are a minority. Most specimens of *T. demissa* have a length/width ratio less than 0.80 because the catacline palintrope is usually flat and only seldom is curved at the apex. Other distinctions appear in the generally less pronounced fold on the dorsal valve of *T. demissa* when compared to that of *T. warreni*. The apical angle of *T. demissa* tends to be less obtuse, nearer a right angle, than that of *T. warreni*, which is usually fairly strongly obtuse.

Most specimens of *T. demissa* come from the San Andres Range and to the west as far as Hermosa where several specimens were taken from the Sly Gap. The species is rare in the Sacramento Mountains, but some of the variants of *T. warreni* with strongly apsacline interareas resemble *T. demissa*.

Thomasaria warreni new species

Plate 35, figures 25–38; plate 36, figures 27–44; plate 40, figures 26, 27; plate 43, figures 1–9

Not Thomasaria altumbona Stainbrook, 1948, p. 777, pl. 2, figs. 38–43.

Small but variable, large adults attaining a width of 20 mm; shells unequal in depth, the ventral valve having a semipyramidal profile, the dorsal valve moderately convex in profile. Hinge wide but narrower than maximum shell width, which is near midvalve anterior to hinge. Sides with distinct shoulders just anterior to hinge but rounded and sloping medially anterior to midvalve. Cardinal extremities varying from angular to rounded. Apical angle greater than 90°. Interarea usually long (in the direction of valve length), variable, strongly to slightly curved and ranging from nearly orthocline to strongly apsacline to procline. Delthyrium long and narrow, partially closed in well-preserved specimens by narrow, oblique marginal plates widest near the dorsal valve and tapering to disappearance apically. Closure of lateral plates not observed. Surface, except lateral margins, without costae but lateral margins provided with three or four obscure costae

best seen in decorticated specimens. Micro-ornament consisting of fine concentric lines bearing minute uniramous spines, usually seen only in specimens with a thin coating of fine shaly matrix.

Ventral valve variable in profile from semipyramidal, with an elongated palintrope, to moderately convex with a nearly orthocline palintrope; anterior profile strongly domed; sulcus originating on the umbo, generally shallow and narrow and producing a narrow tongue that is moderately rounded at its extremity. Sulcus bounded by poorly formed plication on each side; flanks convex but depressed slightly below plications bounding the sulcus especially at anterior. Beak sharply pointed, slightly to fairly strongly incurved.

Dorsal valve shallow and gently convex in lateral profile; broadly and gently convex in anterior profile; cardinal extremities slightly flattened; fold originating at umbo but poorly defined to midvalve where it becomes slightly elevated above slightly convex flanks. Beak small, poorly defined; umbonal region moderately swollen.

Ventral valve interior with strong dental plates and small teeth; dental plates extending along valve floor for about one-quarter valve length measured on its surface. Umbonal and delthyrial chambers often filled apically by adventitious shell substance; apical filling extending about half, or slightly more, of distance from apex to dorsal valve; trace of deltidial structure rarely seen.

Dorsal valve with short flaring socket ridges and thick crural bases.

Measurements (in mm).—

	length (L)	dorsal valve length	hinge width	maxi- mum width (W)	thick- ness (T)	apical angle
USNM 203520a (loc. 506c)	13.8	13.2	14.2	18.0	12.0	92°
USNM 203520b (loc. 506c)	15.0	14.6	14.7	20.0	11.6	99°
USNM 203520c (loc. 506c)	15.6	13.0	15.9	19.3	11.5	108°
USNM 200988c (loc. 506j)	13.4	12.4	13.5	17.4	10.9	103°
USNM 200988a (Holotype; loc. 506j)	15.0	12.8	14.0	17.0	10.8	98°
USNM 200988b (loc. 506j)	13.3	13.2	15.5	17.8	12.0	92°
USNM 201025c (loc. 509o)	14.5	13.3	15.5	18.0	11.9	113°
USNM 201025a (loc. 509o)	17.3	14.1	13.0	18.4	11.1	101°
USNM 201025b (loc. 509o)	14.2	12.5	13.7	15.8	11.0	110°
USNM 203521a (loc. 524m)	14.3	12.3	13.7	16.7	10.6	97°

USNM 203521b (loc. 524m)	13.9	12.8	13.4	18.8	11.0	115°
USNM 203521c (loc. 524m)	13.3	12.0	14.5	17.7	11.0	119°
USNM 200959 (loc. 509n)	12.8	11.0	11.0	14.6	10.7	94°
USNM 200935b (loc. 521c)	12.3	11.9	14.1	18.3	10.6	110°
USNM 200935c (loc. 521c)	13.4	12.4	12.6	15.9	11.3	94°
USNM 200935a (loc. 521c)	13.7	12.2	12.6	15.4	10.2	111°

Mean L/W ratio = 0.86; mean T/W ratio = 0.64.

Diagnosis.—Moderately transverse *Thomasaria* having a moderately to strongly curved interarea in the adult.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, i, j, v; 509g, h, i, k, l, m, n, o, q, r, s, v, w, x; 521c, d, e, k, l, m, n, o, q, r; 522b; 523c; 524m, n; 526k, m; 3045b; 3054h.

Types.—Holotype: USNM 200988a; Figured Paratypes: USNM 200935b, c; 201025a; 201130; 201148; 203520b; Unfigured Paratypes: USNM 200935a; 201025b, c; 203520a, c.

Discussion.—See *Thomasaria demissa* n. sp. for comparison with this species.

This species agrees with *T. altumbona* Stainbrook (1948) in the incomplete development of the lateral plates bounding the delthyrium. It is, in general, a larger form than the one from the Independence Formation and has a stronger fold and sulcus. Stainbrook's illustrated specimens (1945) are unusually large. *Thomasaria warreni* has strong resemblance to *T. rockymontana* (Warren, 1928) but differs in the lack of development of the delthyrial region. In the Alberta species, the lateral plates grow together at the distal part of the delthyrium to form a convex cover, leaving an elongated opening toward the apex. The Alberta thomasarias are evidently as variable as those in New Mexico, and they may be divided ultimately into several species.

Family **CYRTOSPIRIFERIDAE** Termier and
Termier, 1949

Genus **Cyrtospirifer** Nalivkin (*in* Fredericks, 1924)

Cyrtospirifer? *animasensis* (Girty)

Spirifer disjunctus var. *animasensis* Girty, 1900, p. 48, pl. 4, figs. 1–10.

Spirifer whitneyi var. *animasensis* Kindle (*not* Girty, 1900), 1909, p. 25, pl. 9, figs. 1, 1a, 2, 3, 3a.

Cyrtospirifer animasensis (Girty) Stainbrook, 1947, p. 318, pl. 44, figs. 21–24.

This is an often misidentified species, consequently we have queried the citation above. The name has been used for cyrtospiriferids having a wide hinge and

a long steeply apsacline or catacline interarea. Kin-
dle's specimen (1909, pl. 9, figs. 1–3a) is entirely unlike
the one figured by Stainbrook. Furthermore, Girty's
figures indicate a species larger and less transverse
than that figured by Stainbrook. Possibly, Girty's
specimens include more than one species because the
larger ones figured by him are quadrate and not widely
extended at the hinge. This is a rare species in the
Percha (Box Member) and our specimens and Stain-
brook's figured one are inadequate to settle the prob-
lem.

Localities.—507h; 527a.

Types.—?Hypotype: M.A.S. 1594 (=USNM 135250)
in Stainbrook (1947, p. 318, pl. 44, figs. 21–24).

Cyrtospirifer arenarius new species

Plate 30, figures 35–46

About medium size for genus, subrectangular in out-
line, wider than long, hinge narrower than maximum
shell width, which is at about midvalve. Valves sub-
equal in depth. Sides rounded; anterior margin trun-
cated to broadly emarginate. Cardinal extremities ob-
tuse; posterolateral margins varying from 115° to 125°. Interarea long, curved, apsacline to nearly orthocline. Delthyrium wide, open. Surface costate, costae low and rounded, crowded, wider than width of inter-
spaces and 16 to 18 on a side.

Ventral valve moderately convex in lateral profile; broadly convex in anterior profile with median region deeply bisected by deep angular depression representing sulcus. Flanks short and steep. Sulcus originating at beak, widening anteriorly to occupy about half valve width. Sulcus deep and forming broad V-shaped trough ending in fairly long subangular tongue. Sulcus marked by 13 costae. Slopes of flanks to cardinal extremities concave and cardinal extremities slightly concave and having small ears.

Dorsal valve moderately convex in lateral profile but broadly and moderately convex in anterior profile, fold of adult scarcely affecting apex of curve. Fold starting on somewhat swollen umbo, widening to anterior margin but standing only slightly above flanks or flush with them. Flanks convex and moderately steep.

Ventral valve interior with strong, widely divergent dental plates.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 201015d (loc. 522)	21.4	17.1	32.0*	31.0	15.1
USNM 201015a (loc. 522)	22.5	17.0	26.0*	27.0	17.0

USNM 201015c (loc. 522)	20.6	15.3	22.0	26.4	15.0
USNM 201015e (loc. 522)	22.8	18.6	25.8	28.3	16.8
USNM 201015b (Holotype)	21.3	15.0	21.5*	27.3	15.8

Diagnosis.—Medium-sized, subrectangular *Cyrtospirifer* with wide fold and sulcus and broadly emarginate anterior.

Stratigraphic occurrence.—Thoroughgood Formation.

Locality.—522.

Types.—Holotype: USNM 201015b. Figured Paratypes: USNM 201015a, c. Unfigured Paratype: USNM 201015d.

Discussion.—This species suggests some forms of *Cyrtospirifer portae* Merriam (1940) but, when compared to the type specimen of that species, which has similar measurements to USNM 201015c, the Nevada species proves to be more closely costate on the fold and sulcus, and is a thicker specimen with steeper flanks in both valves. *Cyrtospirifer arenarius* n. sp. seems not to have any close relatives in the Devonian of eastern New York, as revealed by the species of *Cyrtospirifer* described and illustrated by Greiner (1957).

Although *C. arenarius* is similar in size to *C. whitneyi* (Hall, 1858), it differs from that species in having a less conspicuous, flatter fold, and a more erect beak; and it is less costate.

Cyrtospirifer breviposticus Stainbrook

Plate 29, figures 42–44

Cyrtospirifer breviposticus Stainbrook, 1947, p. 320, pl. 44, figs. 3–6.

Not *Cyrtospirifer breviposticus* Stainbrook. Johnson, Reso, and Stephens, 1969, p. 1363, pl. 160, figs. 1–18, text-fig. 6.

This is a small, subpyramidal *Cyrtospirifer* (USNM 135257) with narrow hinge and maximum width at midvalve. This may be a young specimen of a larger species but, if so, that species was not found by any of the parties collecting for the Smithsonian Institution. Stainbrook's specimen comes from the Rhodes Canyon Formation "at the east end of Rhodes Pass, San Andres Mountains", from a rock unit that Stainbrook equated with the Percha (Bella = Box Member) that is exposed west of the San Andres Range. The beds from which this specimen (USNM 135257) came are in the type section of the Rhodes Canyon Formation.

Stratigraphic occurrence.—Rhodes Canyon Formation.

Locality.—528c.

Types.—Holotype: USNM 135257, figured in Stainbrook (1947).

Discussion.—The identity of Stainbrook's type with the specimens illustrated by Johnson, Reso and Stephens may be questioned. That Stainbrook's specimen is a youthful one is almost certain, but it is difficult to visualize its growing into the strongly convex forms figured by Johnson, Reso and Stephens. Furthermore, the interarea of the ventral valve would tend to be flatter than that shown in the specimens illustrated by Johnson, Reso and Stephens.

***Cyrtospirifer convexus* new species**

Plate 31, figures 1–10

Small, subtrapezoidal in outline; hinge forming the widest part; cardinal extremities acute, slightly mucronate in some specimens. Sides oblique; anterior margin truncated. Interarea long, slightly curved toward apex, strongly apsacline to catacline. Delthyrium narrow, open except at apex where it is closed by a short apical plate. Surface finely costate, costae low, rounded, separated by spaces narrower than costae; micro-ornament consisting of fine pustules. Twenty-one to 28 costae on each flank of adults and old specimens.

Ventral valve fairly strongly convex and much deeper than dorsal valve in lateral profile; anterior profile a misshapen dome, excavated medially and having sides steeply descending and slightly convex but becoming flat or concave toward the cardinal extremities. Sulcus originating at the beak, widening and deepening anteriorly to occupy about one-quarter of valve width. Sulcus occupied by 11 costae that increase from two at beak by insertion and bifurcation.

Dorsal valve strongly convex in lateral profile; anterior profile broadly convex and having a medial knob representing fold, flanks flat to slightly convex. Fold originating at beak, narrowly rounded and moderately elevated above flanks. Sides of fold not strongly demarcated from flanks in most specimens.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 201095a (loc. 506b)	13.7	13.4	24.8*	18.0	14.6
USNM 201095b	10.5	10.3	20.3	16.0	9.1
USNM 201092a (Holotype; loc. 3026a)	16.4	13.5	27.4*?	19.8	15.0
USNM 201092b	11.8	11.4	21.2*?	14.6	12.3
USNM 201103a (loc. 506)	16.8	16.0	34.0?	19.8	16.8
USNM 201103b (loc. 506)	11.4	11.0	20.6*?	14.6	10.5

Diagnosis.—Wide-hinged *Cyrtospirifer* with long, slightly curved interarea, 21–28 fine costae on each flank, and a convex dorsal valve.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, a, p, q; 507h, m, o; 509b, e; 527a, d, e, f; 3026, a. 3042, s; 3054g.

Types.—Holotype: USNM 201092a. Figured Paratype: USNM 201103a. Unfigured Paratypes: USNM 201103b, 201092b, c, 201095a, b.

Comparison.—This species is akin to *Cyrtospirifer? animasensis* (Girty, 1900) in having a wider hinge that may be slightly mucronate, a more convex dorsal valve, a narrower fold and sulcus and smaller size. It has been usual to identify any small, subconical *Cyrtospirifer* from the Percha Formation as *C.? animasensis* (Girty), but the Colorado form is quite different from those of the Percha (see *Cyrtospirifer? animasensis* above).

***Cyrtospirifer pyramidalis* new species**

Plate 31, figures 17–42

About medium-sized for genus, wider than long, subrectangular in outline; sides extending obliquely medially; anterior emarginate in dorsal view; valves unequal, ventral valve semipyramidal and dorsal valve shallow; interarea very long and flat; delthyrium about twice as long as wide, with apical plate and pseudodeltidium in rare specimens. Beak flat or slightly curved; interarea usually catacline. Cardinal extremities acute, hinge forming widest part. Valves finely costate, about 20 costae on a side, the ones in cardinal extremities fine and often indistinct. Entire surface covered by fine radial lines and granules.

Ventral valve gently convex in lateral profile; sulcus originating at beak, widening and deepening anteriorly to occupy about one-third the midwidth; sulcus bearing six or seven costae; tongue varying from subangular to moderately rounded. Flanks at cardinal extremities flattened to slightly concave.

Dorsal valve fairly evenly and moderately convex in lateral profile; anterior profile broadly and fairly strongly domed, the median apex bearing a small rounded knob representing fold. Fold originating at beak, narrow and only gently elevated above flanks, which are flattened in anterior view but gently swollen in lateral view.

Ventral valve interior with long divergent dental plates extending for about one-third valve length.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 201036a (Holotype; loc. 524z)	11.0	12.7	23.4*	19.3	11.9
USNM 201036b	7.8	9.7	18.2*	14.8	11.8

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 201053a (loc. 521h)	8.2	9.1	17.4*	13.4	9.1
USNM 201000a (loc. 509u)	10.5	11.6	—	15.7	12.5
USNM 203544 (loc. 528j)	11.4	11.2	18.0+	15.6	11.8

Diagnosis.—Transverse, hemipyramidal *Cyrtospirifer* with long catacline interarea.

Stratigraphic occurrence.—Rhodes Canyon Formation; Contadero Formation.

Localities.—Contadero Formation: 509t; 521f; Rhodes Canyon Formation: 509u; 521h; 523p; 524e, v (float), z; 528j; 3054q.

Types.—Holotype: USNM 201036a. Figured Paratypes: 201000a, b, 201036b, 201053a, 203544. Unfigured Paratypes: USNM 201000b, 201053b.

Discussion.—It was at first thought that this species is an adult form of *Cyrtospirifer breviposticus* Stainbrook (1947), which comes from the Rhodes Canyon Formation a mile south of the entrance to Rhodes Canyon. Comparison of *C. pyramidalis* with Stainbrook's type specimen (USNM 135257) shows only remote similarities. Both species are semipyramidal but that is where the similarity ends because Stainbrook's species has rounded cardinal extremities and a hinge narrower than the midwidth. The sides of his species are well-rounded and the fold and sulcus are relatively wide. Although the two species apparently occur at the same stratigraphic levels, Stainbrook's cannot even be construed as the young of *C. pyramidalis* because all of the immature specimens of that species are wide-hinged. *Cyrtospirifer pyramidalis* is different from *C. posticus* Johnson, Reso, and Stephens (1969) (not Stainbrook, 1947) in being smaller, wider, with acute cardinal extremities and a more steeply inclined ventral palintrope.

***Cyrtospirifer rotundus* new species**

Plate 30, figures 1–23

?*Spirifer whitneyi* var. *animasensis* (Girty) Kindle, 1909, p. 25, pl. 9, figs. 21–24.

Small for genus, subquadrate in outline, width greater than length; hinge usually widest part; cardinal extremities acute or extended into small ears. Sides rounded, slightly oblique; anterior margin truncated narrowly; interarea long, gently curved, steeply apascline. Delthyrium apically closed by a short plate. Surface finely costate, 18–20 costae on each flank, last three or four very small; costae flatly rounded, fairly wide and separated by spaces narrower than costae.

Ventral valve semipyramidal, moderately convex in lateral profile but narrowly domed in anterior profile and having sides flatly convex, steep and becoming concave at the cardinal extremities. Sulcus originating at beak, narrow and shallow, occupying about one-third maximum width but producing a fairly long, narrowly rounded to subangular tongue.

Dorsal valve fairly strongly convex in lateral profile and narrowly domed in anterior profile, the center occupied by narrow knob representing fold. Flanks gently rounded and steep. Fold beginning at beak and widening moderately anteriorly, fold fairly strongly elevated above flanks at anterior, and moderately rounded.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 201097b (loc. 527a)	13.7	12.2	20.0*	17.0	12.8
USNM 201097a	16.4	15.1	18.4*	17.7	15.0
USNM 201096 (Holotype; loc. 506)	15.3	12.7	20.4*	16.9	14.8
USNM 200911 (loc. 3029)	11.8	11.4	24.8*	14.7	10.8

Diagnosis.—Small, rather narrow, semipyramidal *Cyrtospirifer* having 18–20 costae on each flank.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, b, q; 527a, p; 3029; USGS 509.

Types.—Holotype: USNM 201096. Figured Paratypes: USNM 201097a, b.

Discussion.—This species is readily separated from *Cyrtospirifer convexus* n. sp. by its much narrower form, less extended hinge, less oblique lateral margins and more elevated fold. A similar appearing, but larger, species occurs in the West Range Limestone on Dutch John Mountain, north of Pioche, Nevada (USNM 204956).

Cyrtospirifer rotundus is similar to *C. posticus* Johnson, Reso, and Stephens (1969) in size and general appearance, but *C. rotundus* has a stronger, more rounded fold, shallower sulcus and more incurved beak.

***Cyrtospirifer* cf. *C. thalattodoxa* Crickmay**

Plate 30, figures 24–29

Cyrtospirifer thalattodoxa Crickmay, 1952, p. 601, pl. 72, figs. 1–7.

Referred here are specimens of *Cyrtospirifer* having a wide and barely perceptible fold by virtue of lack of elevation of the flanks. Most of the specimens are poor, but the best one, a fairly young adult (USNM 200968), measures (in mm): length 13.7, dorsal valve length 14.0,

hinge width 28.4 (points on both sides broken off), midwidth 27.0, thickness 14.8. The ventral valve is subconical in lateral profile and the interarea is long and only slightly curved near the beak. The dorsal valve is moderately convex and the fold is only slightly elevated and occupies about a third the valve width. About 20 pustulose costellae on a side.

Diagnosis.—Wide-hinged, finely costate *Cyrtospirifer* with wide, scarcely elevated fold.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—521d, h.

Types.—Figured Hypotype: USNM 200968.

***Cyrtospirifer whitneyi* (Hall)**

Plate 30, figures 30–34

Spirifer whitneyi Hall, 1858, p. 502, pl. 4, fig. 2; 1867, p. 245, 417; Hall and Clarke, 1893, p. 24, 27, pl. 30, figs. 18, 19.

A few specimens of compact form and moderately elevated fold and sulcus are referred to Hall's species. The specimens are all very poorly preserved.

Diagnosis.—*Cyrtospirifer* with wide sulcus, wide fold moderately elevated above the flanks.

Stratigraphic occurrence.—Sly Gap Formation; Contadero Formation.

Localities.—Sly Gap: 509s, z; 521d, u. Contadero: 509t; 521g; 523n, q; 526g.

Types.—Figured Hypotype: USNM 201102.

***Cyrtospirifer* species 1**

Plate 31, figures 48–58

About medium size for genus, roundly elliptical in outline, hinge narrower than greatest width at midvalve; sides rounded, anterior margin gently emarginate; posterolateral margins forming angle of 90° in young specimens to 120° in old specimens. Cardinal extremities obtuse. Interarea long, fairly to strongly curved; beak suberect to strongly incurved. Surface finely costate, costae low, rounded and separated by spaces narrower than costae. Sixteen costae on a side.

Ventral valve fairly strongly convex in lateral profile but fairly strongly domed in anterior profile, median region deeply indented by a wide sulcus, the flanks convex and steep. Sulcus originating at beak, wide and deep, occupying about half maximum width. Tongue fairly long and narrowly rounded.

Dorsal valve moderately convex in lateral profile; broadly domed in anterior profile with flattish steeply descending flanks. Fold originating at beak, moderately elevated at mid-fold to form a somewhat carinate but low elevation.

Ventral valve with fairly long apical plate.

Measurements (in mm).—

	dorsal valve length	hinge width	maxi- mum width	thick- ness	apical angle	
USNM 203535 (loc. 522)	21.1	15.6	19.8	23.4	15.4	95°
USNM 203536	25.3	18.9	26.8	32.1	20.3	121°

Diagnosis.—Elliptical *Cyrtospirifer*, anteriorly emarginate, with wide fold and sulcus and curved interarea.

Stratigraphic occurrence.—Thoroughgood Formation.

Locality.—522.

Types.—Figured Specimens: USNM 203535, 203536.

Discussion.—All of Greiner's (1957) species from the New York Upper Devonian have acute cardinal extremities and usually are mucronate. *Cyrtospirifer portae* Merriam (1940) has some resemblance to this New Mexico species, but the Nevada form does not have the rounded sides and subcarinate fold.

***Cyrtospirifer* species 2**

Plate 30, figures 47–50; plate 31, figures 43–47

Medium-sized for genus, length equal to 60 percent of width; outline forming a wide pentagon; hinge wide, not equal to maximum width, which is just anterior to narrowly rounded cardinal extremities; anterolateral margins straight, strongly oblique to midline; anterior margin truncated; posterior margins broadly obtuse and forming angle of 145°. Interarea fairly long, curved, gently apsacline; delthyrium questionably open. Surface finely costate, costae broadly rounded and separated by spaces narrower than the costae, which number about 22 on a side.

Ventral valve gently convex in lateral profile, broadly convex in anterior profile, the lateral slopes flattened and forming a long, only moderately steep descent, median part having subangular depression. Sulcus originating at beak, widening anteriorly to occupy somewhat less than one-third of width and broadly V-shaped.

Dorsal valve gently convex in lateral profile, broadly and unevenly convex in anterior profile; median region of profile subangular with sides sloping strongly, flattened toward midvalve but becoming gently concave toward extremities. Fold beginning at the beak, widening rapidly anteriorly but merging laterally into slightly convex flanks at anterior, thus poorly defined.

Measurements (in mm).—

	dorsal valve length	hinge width	maxi- mum width	thick- ness	apical angle	
USNM 200969 (loc. 522)	20.4	16.8	32.0*	35.5+2?	13.5	145°

Diagnosis.—Wide, somewhat compressed *Cyrtospirifer* having a low fold but moderately deep V-shaped sulcus.

Stratigraphic occurrence.—Thoroughgood Formation.

Locality.—522.

Types.—Figured Specimens: USNM 200969, 205260.

Discussion.—In its great width and compressed form, this species is unlike any other New Mexico form. It is entirely unlike any of the species of *Cyrtospirifer* figured by Greiner (1957) from the Upper Devonian strata of western New York.

Cyrtospirifer species 3

Plate 31, figures 11–16

Small, wider than long with narrowly and laterally extended cardinal extremities. Sides forming a sigmoidal curve; anterior margin narrowly emarginate. Beak slightly incurved, interarea long and approximately catacline. Delthyrium open. Costate, costae narrow and separated by spaces narrower than costae; 21 costae on a side; twelve costae, finer than those on the flanks, marking fold; one less in sulcus.

Ventral valve slightly deeper than dorsal valve, moderately convex in lateral profile, strongly and broadly domed in anterior profile; sulcus originating at beak, marked by costae finer than those of flanks; tongue short and rounded. Flanks moderately convex, moderately steep becoming flattened at cardinal extremities.

Dorsal valve moderately convex in lateral view, strongly domed in anterior view and with fold forming a knob on dome. Fold beginning at beak, rounded in cross section but not strongly elevated above flanks. Flanks having about same convexity as those of ventral valve, becoming flattened to slightly concave toward the cardinal extremities.

Diagnosis.—Wide-hinged, short *Cyrtospirifer*, finely costate with finer costae on the fold and sulcus than on the flanks.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—521d.

Types.—Figured Specimen: USNM 201023.

Discussion.—This species is most like *C. convexus* from the Percha Formation, but it differs in having a more acute ventral tongue, narrower cardinal extremities, more swollen flanks. We have only a single specimen of this distinctive species.

Cyrtospirifer species 4

Plate 39, figures 38–42

A single specimen of about average size for the genus measures (in mm): length 16.5, dorsal valve length 17.0, hinge width ca. 33.0 (based on half measure), midwidth 24.0, thickness 16.0. The specimen has a long, procline, slightly curved interarea. The sides are oblique and slightly concave to the prominent ear(s). The ventral valve is moderately convex and somewhat pyramidal; the dorsal valve is gently convex in lateral profile and broadly domed in anterior profile. The sulcus of the ventral valve is broad and fairly deep, broadly V-shaped in profile. The fold is low and scarcely defined. The costae are narrow and fairly even over the whole surface, about 20 on each flank and 15 on the fold. The anterior commissure is broadly uniplicate and slightly angulated in the middle. Surface finely pustulose.

Diagnosis.—Medium-sized *Cyrtospirifer* having a poorly defined fold but well-marked sulcus and fairly uniform costae over the whole surface.

Stratigraphic occurrence.—Sly Gap Formation.

Locality.—USGS 543.

Types.—Figured Specimen: USNM 207696.

Discussion.—This species is unlike any figured by Greiner (1957) from the Upper Devonian rocks of New York. The combination of a procline interarea and faintly developed fold seem to be unique in the genus. The species is reminiscent of *C. thalattodoxa* Crickmay (1952), but that species has a more prominent fold and the interarea is not procline.

Cyrtospirifer species 5

Plate 39, figures 43, 44

A small *Cyrtospirifer* from the Caballos Mountains is represented by three valves, two ventral and one dorsal, all impressions in a fine-grained sandstone. The specimens are wider than long and with slightly mucronate cardinal extremities. The valves are ornamented by low broadly rounded costae separated by narrow interspaces. The sulcus is shallow and is occupied by a median costa and two lateral ones. The dorsal valve fold is narrow and low, demarcated by narrow grooves on each side and marked by four costae. The entire surface is strongly granulose. The only measurable specimen (USNM 207703a) is 12 mm long, and about 25 mm wide (based on the half measure).

Diagnosis.—Small, wide, alate *Cyrtospirifer* with subdued fold and sulcus.

Stratigraphic occurrence.—Sly Gap? (uppermost sandstone).

Locality.—522s.

Types.—Figured Specimens: USNM 207703a, b.

Discussion.—We have been unable to find a described species like this one. It is possible that these

specimens represent youthful forms of a normally larger species. Close check of all the specimens from the Sly Gap Formation in the San Andres and Sacramento Mountains failed to bring to light any specimens like these or any that might be larger adults.

HISPIDARIA new genus
[Latin, *hispidus* = bristly]

Type species.—*Hispidaria posterogranulosa* n. sp.

Diagnosis.—Small, strongly costate, wide-hinged cyrtospiriferoids having the bristly to granular ornament which also occupies most of the interarea.

Discussion.—This is a small and obscure group, related to *Cyrtospirifer* Nalivkin (in Fredericks, 1924), that occurs in the Famennian of New Mexico. The shells are fairly strongly costate and the costae are densely covered by coarse granules that are often lengthened into spines. This micro-ornament is not confined to the costate part of the shells but covers the parts of the interarea adjacent to the posterior margin and extending in a dorsal direction nearly to the interarea of the dorsal valve.

Hispidaria posterogranulosa new species
Plate 32, figures 22–34

Small, wider than long, with widely extended hinge and acute cardinal extremities. Sides strongly oblique. Interarea long, strongly apsacline, divisible into two parts, one vertically striated part surrounding the delthyrium and a granulose or bristly part between the striated portion and the posterior margin. Delthyrium open except for a tiny apical plate. Surface completely costate, costae elevated, narrowly rounded and separated by spaces nearly equal to the width of costae; 12 costae on a side in adult. Micro-ornament consisting of coarse, crowded granules and a few rows of spines in the sulcus and on the fold.

Ventral valve moderately convex in lateral profile and broadly triangular in anterior profile, apex being indented by sulcus that originates at beak and occupies about one-quarter maximum width. Sulcus extended into a short angular tongue. Sulcus occupied by one costa at apex dividing almost immediately after its appearance; other costae intercalated, primary pair bearing spines. Flanks flattened, moderately steep.

Dorsal valve very gently convex in lateral profile and very broadly and flatly triangular in anterior profile, the apex of the triangle marked by a rounded knob. Flanks barely convex and gently sloping. Fold originating at the beak, narrowly rounded, moderately elevated anteriorly and marked initially by two costae. Initial two costae forming sides of fold; inserted inside them is a large anteriorly bifurcating costa that bears minute spines.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 201106 (Holotype; loc. 3026a)	10.0	8.6	18.0*	13.6	6.7

Diagnosis.—Small, wide-hinged *Hispidaria* with interarea partially granulose.

Stratigraphic occurrence.—Percha Formation (Box Member).

Locality.—3026a; 3042.

Types.—Holotype: USNM 201106. Figured Paratype: USNM 201109.

Discussion.—This species is unlike any *Cyrtospirifer* known to us. It differs from *H. spinosa* n. sp., which also has a partially granulose interarea, in its greater size, greater width, and strongly oblique lateral margins. This is a very rare species.

Hispidaria spinosa new species
Plate 32, figures 1–21

Syringospira prima Cooper (not Kindle, 1909), 1954, pl. 37, figs. 15–18.

Small, cyrtiniform, with hinge forming widest part; cardinal extremities acute; sides oblique, nearly straight to gently rounded; anterior margin truncated. Interarea long, apsacline, portion bounding posterolateral margin strongly granulose or spinose. Delthyrium with short apical foramen. Each flank occupied by 11 or 12 moderately elevated, rounded costae separated by spaces slightly less wide than costae; flanks occasionally with intercalated costae. Micro-ornament consisting of mat of coarse granules that are often extended into minute spines, on costae and ventral valve interarea.

Pedicle valve gently convex, most so in anterior half in lateral profile; anterior profile forming a fairly high triangle with fairly steep sides and apex slightly depressed by the sulcus. Sulcus originating at beak with single costa that divides early. Sulcus moderately deep, occupying about a third of width, and usually occupied anteriorly by five costae. Tongue short and rounded.

Dorsal valve fairly evenly and gently convex in lateral profile, broadly and very gently convex in anterior profile. Fold originating at beak, low throughout its extent but moderately elevated anteriorly. Fold consisting of one costa at apex, bifurcating close to the apex, the two costae thus formed bounding the sides of fold; usually three costae intercalated between the primary two.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 201126 (Holotype; loc. 527d)	8.6	6.9	13.2*	9.8	5.2
USNM 201108 (loc. 527a)	8.4	7.4	10.8*	9.0	5.5
USNM 203512 (loc. 527e)	9.4	8.3	12.8*?	10.8	6.4
USNM 201125 (loc. 3026a)	8.8	8.0	16.6*	11.7	7.3
USNM 201107 (loc. 506q)	7.0	5.7	10.6	8.2	4.3

Diagnosis.—Small, cyrtinoid *Hispidaria* with very coarse granules and spines.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, q; 507h, n, u; 509a; 527a, d, e; 3026, a; 3042.

Types.—Holotype: USNM 201126. Figured Paratypes: USNM 201107a, 201108, 201125. Unfigured Paratypes: USNM 201107b, 203512.

Discussion.—Like *Hispidaria posterogranulosa*, n. sp., this one has a granulose outer part of the interarea. It differs from that species in being smaller, narrower, with less oblique sides, and an outline and profile like *Cyrtina* Davidson (1858). The micro-ornament of *H. spinosa* is also stronger than that of *H. posterogranulosa* and is very prominent for such a small shell. This is also a very rare species.

CYRTIORINA new genus

Large, wider than long, hinge less than maximum shell width at midvalve. Unequally convex, ventral valve more convex. Anterior commissure strongly uniplicate; ventral tongue long. Beak strongly incurved over moderately long, concave, apsacline interarea. Delthyrium covered by convex, often thick, pseudodeltidium. Surface completely covered by costellae rounded posteriorly, flattening anteriorly, and becoming marginally obsolete in old shells. Costellae covered by minute concentric and radial lines that form fine granules at their intersection.

Ventral valve interior with apical plate, often thickened; dental plates reaching nearly to midvalve. Dorsal valve interior with narrow socket plates supporting long, bowed crura.

Type species.—*Cyrtospirifer kindlei* Stainbrook, 1947, p. 318, pl. 44, figs. 1, 2, 7–12.

Diagnosis.—Large, costellate, uniplicate *Cyrtospiriferidae* with pseudospondylium and apical plate.

Discussion.—Stainbrook's holotype is a somewhat distorted specimen having an extended point on one side. In all of our collections, and among Stainbrook's

unfigured paratypes, not one has lateral points at the cardinal extremities. Except for its cardinal extension, Stainbrook's type has all other features conforming to those of the majority as outlined above.

Cyrtiorina is externally similar to *Uchtospirifer* Lyaschenko (1957) but differs in having an apical plate. It is like *Cyrtiopsis* Grabau (1923) in having a pseudospondylium, often showing traces of a round foramen, a feature of *Cyrtiopsis*. The latter, however, has no apical plate. *Dmitria* Sidiachenko (1961), a Russian genus, resembles *Cyrtiorina* in its fine costellae and large size, but differs in having barely perceptible fold and sulcus.

Spirifer monticola Haynes (1916), of the Three Forks Formation in Montana, is another species of *Cyrtiorina*.

Cyrtiorina kindlei (Stainbrook)

Plate 32, figures 35–41; plate 41, figures 50–53

Spirifer whitneyi Kindle, 1909 (not Hall, 1858), p. 24, pl. 8, figs. 2–5a.

Cyrtospirifer kindlei Stainbrook, 1947, p. 318, pl. 44, figs. 1, 2, 7–12.

This large and distinctive brachiopod is one of the commonest species in the Percha. It occurs from uppermost nodular beds of the Ready Pay Member throughout the succeeding Box Member.

Stratigraphic occurrence.—Percha Formation (Ready Pay Member, Box Member).

Localities.—506, a, b, p, q; 507a, b, d, e, f, g, h, n, o, q, r, t, v, x; 509a, c, d; 527a, c, d, e, f, g, n; 3026, a; 3029; 3030, 3031a, b; 3034; 3035; 3042, s; USGS (Kirk) 459; 509; 512.

Types.—Holotype M.A.S. 1591 (=USNM 135286). Paratypes: M.A.S. 1519A (=USNM 135237); M.A.S. 1591B (=USNM 135237); M.A.S. 1591C (=USNM 135283), figured in Stainbrook (1947). *Spirifer whitneyi* Kindle (not Hall) figured by Kindle, 1909, USNM 62029a, b; 62031. Figured Hypotypes: USNM 201150a; 201151a, i; 203528a, c; 203529b, c.

Genus UCHTOSPIRIFER Lyaschenko, 1957

Uchtospirifer? rarus new species

Plate 33, figures 1–8

Small for genus, quadrate in outline, about 0.8 as long as wide; hinge wide but not quite equal to the maximum valve width, which is located at about midvalve; cardinal extremities forming small ears. Sides fairly well rounded; anterior margin truncate; posterolateral margins forming an angle of 110°. Interarea moderately long, curved, orthocline; flattened pseudodeltidium present. Beak strongly incurved over interarea. Anterior commissure strongly uniplicate. Surface costate, each flank bearing about 13 narrowly

rounded costae separated by spaces nearly as wide as costae. Sulcus occupied by four costae and fold by five. Strong concentric lamellae appearing at the anterior. Micro-ornament not preserved.

Ventral valve strongly convex in lateral profile and most so in posterior part; anterior profile broad, evenly convex dome with moderately sloping sides but excavated medially by the sulcus. Sulcus originating at beak, deepening and widening anteriorly to occupy about 60 percent of width. Sulcus occupied by one costa near the beak, others being intercalated anteriorly. Flanks gently convex and steep-sided. Tongue long, rounded.

Dorsal valve less convex and less deep than the ventral valve in lateral profile; anterior profile forming broad triangle, with fold forming low bulge at apex. Fold initiating at beak narrowly rounded, moderately elevated above flanks anteriorly. Fold initially with two costae that bifurcate not far anterior of beak; other costae intercalated.

Measurements (in mm).—USNM 200989 (Holotype): length 15.6, dorsal valve length 12.2, hinge width 15.2, maximum width 17.7, thickness 11.2, apical angle 110°.

Diagnosis.—Small *Uchtospirifer*? having 13 costae on each flank, a flattened pseudodeltidium, and narrow fold and sulcus.

Stratigraphic occurrence.—Contadero Formation.

Locality.—523q.

Types.—Holotype: USNM 200989.

Discussion.—This species is doubtfully placed in *Uchtospirifer* even though it has a pseudodeltidium. It is completely unlike *Cyrtiorina kindlei* (Stainbrook, 1947) in size and ornament.

Genus SYRINGOSPIRA Kindle, 1909

Syringospira prima Kindle

Syringospira prima Kindle, 1909, p. 29, pl. 7, figs. 8–8d; pl. 8, figs. 1–1a. Cooper in Shimer and Shrock, 1944, p. 327, pl. 125, figs. 12–14; Cooper, 1954, p. 326, pl. 36, figs. 1–7, 11; pl. 37, figs. 1–14 (not figs. 15–18).

This is an uncommon species in the Percha Formation (Box Member), and is also found in the upper part of the black shale (Ready Pay Member) at the appearance of the first of the calcareous nodules. It is commonly enclosed partially or wholly by the nodules. It also occurs in all parts of the calcareous, greenish nodular shales of the Box Member but is scattered and often rare. There too, it may be enclosed by a nodule.

Cooper (1954) described this species in detail.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—Percha Fm. (Box Mbr.): 506, a, b, p, q; 507a, b, c, d, e, h, i, j, m, o, p, x, z; 509a, b, e;

527a, d, e, f, g, j, k, p; USGS 4804; 3026, a; 3031a, b; 3034; 3042, s.

Types.—Holotype: USNM 62027. Figured Paratype: USNM 62028; primary types figured by Kindle (1909). Hypotypes figured by Stainbrook (1947): M.A.S. 1582A, B (=USNM 135239a, b). Hypotypes figured by Cooper (1954): USNM 123358; 123359a–c; 123361a; 123363a; 123364; 123365a, b; 123366a, b; 123367; 123368a; 123369a; 123370a.

Genus TENTICOSPIRIFER Tien, 1938

Tenticospirifer cf. *T. cyrtinaformis* (Hall and Whitfield)

Plate 33, figures 9–15

Spirifera cyrtinaformis Hall and Whitfield, 1872, p. 238, pl. 11, figs. 21–24.

Platyrachella cyrtinaformis (Hall and Whitfield) Fenton and Fenton, 1924, p. 162, pl. 29, figs. 1–7.

This species is represented by eight specimens from four localities. The largest, best, and illustrated specimen is about normal size for the species. It is widest at the hinge and the sides slope gently medially. The ventral valve is semipyramidal, the interarea long and catacline, the delthyrium narrow. The dorsal valve is gently convex and the flanks slope to cardinal extremities. The fold is poorly defined but is best seen at the anterior commissure, which is uniplicate. The surface is marked by fine costae separated by spaces of about equal width.

Measurements (in mm).—USNM 201105: length 10.6, dorsal valve length 11.3, hinge width 16.6 (not complete), midwidth 12.5, thickness 10.8.

Diagnosis.—Finely costate, medium-sized *Tenticospirifer* having a poorly developed fold and sulcus.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506j; 509q; 521d; 526x.

Types.—Figured Hypotype: USNM 201105.

Genus INDOSPIRIFER Grabau, 1931

Indospirifer anomala new species

Plate 33, figures 45–54

About medium-sized for genus, transversely rectangular in outline; hinge forming widest part and cardinal extremities an acute angle, about 85°. Sides gently rounded and sloping slightly toward midvalve; anterior narrowly truncated. Interarea wide and long (in the direction of the valve length), curved and strongly apsacline. Beak small and strongly incurved. Valves multicostate, each flank having 11 or 12 narrowly rounded costae with interspaces slightly wider than costae; fold with initial costa that divides anteriorly into two that form the crest of the fold; sides of fold having two or three costae; costae in sulcus variable.

Ventral valve moderately convex in lateral profile but with umbo strongly curved; anterior profile broad-

ly convex and median region gently depressed by sulcus. Flanks bounding sulcus moderately swollen; sulcus originating at beak, widening anteriorly to occupy slightly less than half hinge width; tongue long and anteriorly rounded.

Dorsal valve flatly convex in lateral profile but with umbo slightly more curved; anterior profile forming a broad triangle with the fold forming crest and flattened flanks sloping laterally. Fold originating at beak, narrowly rounded and occupying one-third or somewhat less of hinge width. Fold strongly elevated above flanks only in anterior half.

Measurements (in mm).—

	length	dorsal valve length	hinge width	mid- width	thick- ness
USNM 200905 (loc. 509z)	21.0	16.9	22.0?	26.4	15.2
USNM 200904 (Holotype; loc. 506j)	23.8	18.0	33.0	29.2	16.8

Diagnosis.—*Indospirifer* of medium size having a rounded fold, slightly acute cardinal extremities, and 11–12 costae on each flank.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506j; 509s, z; 521d, q; 524m, w.

Types.—Holotype: USNM 200904. Figured Paratype: USNM 200905.

Discussion.—This species differs from *I. orestes* (Hall and Whitfield, 1872) and *I. exfoliata* n. sp. in its larger size, rounder fold, less acute cardinal extremities and in having more costae on the flanks. This is a rare species in the New Mexico Frasnian.

***Indospirifer exfoliata* new species**

Plate 33, figures 21–34

Spirifer strigosus Stainbrook (not Meek, 1876), 1948, p. 777, pl. 2, figs. 5–8.

Small- to medium-sized for genus, wider than long, semielliptical in outline; hinge forming widest part; cardinal extremities usually acute. Anterior commissure narrowly uniplicate. Interarea wide, short in direction of valve length, moderately curved and apsacline. Beak strongly incurved. Surface multicostate, each flank marked by eight costae, the narrow fold by two prominent summit costae and one on each slope; sulcus marked by strong median costa and variable number of lateral subsidiary ones.

Ventral valve moderately convex in lateral profile but broadly convex in anterior profile, crest of curve indented medially by shallow sulcus. Sulcus originating at beak, widening and deepening anteriorly; sulcus width equalling less than half hinge width; flanks bounding sulcus swollen and steep.

Dorsal valve having about same depth as ventral

valve; broadly convex, middle with a narrow bulge representing fold; gently convex in lateral profile; flanks flattened, sloping moderately. Fold originating at beak and formed of one costa that divides at beak to form crest of fold; additional costae added on steep slopes of fold.

Measurements (in mm).—

	length (L)	dorsal valve length	hinge width (W)	mid- width	thick- ness	L/W ratio
USNM 200881 (loc. 506c)						
USNM 200882 (Holotype; loc. 506c)	15.7	12.9	20.0?	21.0	11.6	0.75
	17.1	14.0	22.3	21.0	12.9	0.81

Diagnosis.—Small to medium *Indospirifer* with narrow fold and sulcus.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c; 509g, i, k, m, w; 521d, l, n, r; 524n; 526q.

Types.—Holotype: USNM 200882. Figured Paratype: USNM 200881.

Discussion.—This species is clearly related to *Indospirifer orestes* (Hall and Whitfield, 1872) as it has the same type of narrow fold crested by two costae with subsidiary ones appearing on the slopes. However, it is smaller, with a less broad interarea and a more strongly incurved ventral beak.

Stainbrook (1948) referred specimens of this species to *I. strigosus* (Meek, 1860) but the latter is a large species with medially sloping sides, rather acute cardinal extremities (63°), and a proportionately narrower fold and sulcus. Furthermore, *I. exfoliata* has no bifurcating lateral costae.

***Indospirifer* aff. *I. orestes* (Hall and Whitfield)**

Plate 33, figures 16–20

Spirifer orestes Hall and Whitfield, 1872, p. 237, pl. 11, figs. 16–20.

Two specimens having characters of some examples of *Indospirifer orestes* was taken from Capitol Peak in the San Andres Range (locality 521k, u). Measurements (in mm) of one (USNM 200990) are: length 16.0, dorsal valve length 11.4, hinge width 13.2, maximum width 18.3, thickness 10.3. The ventral valve is strongly umbonate and the beak overhangs the long curved apsacline interarea. The cardinal extremities and sides are well-rounded. The specimen suggests the one figured by Hall and Whitfield (1872, pl. 11, fig. 16; repository unknown), which has well-rounded sides. Fenton (1931, p. 138) in his discussion of the *Spirifer orestes* Phratry mentions the similarity of Hall's specimen (fig. 16) to *S. euginus* Fenton (1931). *Spirifer euginus repositus* Fenton (1931), which Fenton illustrated as figure B on p. 201, is closest to the Capitol

Peak specimen. This specimen has strongly rounded sides and a narrow hinge and thus is, in these gross characters, like the New Mexico form. Unfortunately, the Sly Gap species does not retain any of the fine ornament, thus negating a more positive identification.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—521k, u.

Types.—Figured Hypotype: USNM 200990.

***Indospirifer strigosus* (Meek)**

Plate 33, figures 35–44

Spirifer macra Meek (not Hall, 1857), 1860, p. 309.

Spirifera strigosa Meek, 1860; note appended to extras of the above (see Meek, 1877).

Spirifer strigosus Meek, 1876, p. 347, pl. 1, fig. 5.

Spirifer (*Trigonotreta*) *strigosus* Meek, 1877, p. 43, pl. 3, fig. 5.

Not *Spirifer strigosus* Meek. Stainbrook, 1945, p. 52, pl. 5, figs. 14–21; 1948, p. 777, pl. 2, figs. 5–8.

Inasmuch as “*Spirifer*” *strigosus* Meek has been identified in the Independence and Sly Gap faunas, it is not amiss to make a few remarks on the type specimens of that species and to point out the important differences between them and the specimens erroneously identified. The type lot of *S. strigosus* Meek is preserved in the U.S. National Museum of Natural History as specimens USNM 629a and 629b. Both specimens have been badly decorticated and mutilated: 629a, the holotype, lacks much of the posterior half, and one side of the dorsal valve. Both of these parts have been restored in beeswax; the restoration is not very accurate and the shell is now badly scarred and worn. Specimen 629b lacks most of the anterior half of both valves. The beak and umbonal region of the ventral valve have been restored in beeswax.

The unrestored parts of the holotype indicate a specimen with hinge wider than the midwidth and with lateral margins sloping strongly medially, thus emphasizing the angularity of the cardinal extremity, which is about 62°. The fold at the anterior of the holotype is narrow and strongly elevated, occupying about 45 percent of the width. As shown by the paratype, the fold originates on the umbo and is formed of two costae that extend on the crest of the fold to the anterior margin. Two additional costae are added anteriorly on the fold slopes. The sulcus has one large median costa and two secondary costae on each side. Each flank of the holotype has nine or ten costae, the tenth obscure and questionable.

Stainbrook (1945, p. 53) speaks of bifurcated costae in *S. strigosus* Meek, but the holotype shows no such costae on the dorsal valve, perhaps because the posterior half of the dorsal valve is restored in wax. On the ventral valve, a costa is intercalated near the beak but none of the other costae show bifurcation. On the

other hand, the paratype has bifurcation of the costae immediately adjacent to the fold on the left side, and on the right side of the fold a fascicle of three costae appears. Bifurcation of the costae is rare in *I. orestes* (Hall and Whitfield, 1872). Stainbrook figures bifurcation on specimens referred to *S. strigosus*, but the shape of the specimens and the bifurcation are unlike either of Meek's specimens. This suggests that *S. strigosus* Meek occurs neither in the Independence Shale of Iowa nor in the Sly Gap of New Mexico.

Stratigraphic distribution.—Upper Devonian.

Locality.—Neils Valley, east of Eureka, Nevada.

Types.—Holotype: USNM 629a; Figured Paratype: USNM 629b.

Superfamily **RETICULARIACEA** Waagen, 1883

Family **RETICULARIIDAE** Waagen, 1883

Genus **WARRENELLA** Crickmay, 1953

***Warrenella magna* new species**

Plate 34, figures 1–19

Large, broadly elliptical in outline; greatest width at midvalve; sides strongly rounded; anterior margin truncated; posterior with ventral umbonal region strongly protuberant beyond posterior margin of dorsal valve. Hinge wide, narrower than midwidth and from 0.6 to 0.75 of midwidth. Beak strongly incurved; interarea fairly long (in direction of valve length), curved, orthocline to strongly apsacline. Delthyrium covered by moderately convex apical plate. Surface covered by closely crowded concentric lines of minute single-barreled spines, about 12 to the mm.

Ventral valve moderately convex in lateral profile but having the umbonal region narrowly convex; anterior profile strongly and broadly convex and having the median region marked by a fairly deep depression representing sulcus. Umbonal region and flanks swollen; sulcus bounded by a fairly strong plication that merges laterally into swollen flank. Sulcus originating five to ten mm anterior to beak, shallow but widening anteriorly to equal 40 to 45 percent of midwidth. Tongue moderately long, broadly rounded to truncated at its free end.

Dorsal valve gently convex in lateral profile but with umbonal region forming most convex part; anterior profile broadly triangular, fold forming the apex of the triangle and flattened flanks forming the two sides. Umbonal region narrowly swollen, swelling extending into fold, which is elevated above flanks at about midvalve, continuing to heighten anteriorly; flanks depressed or slightly deflected in ventrad direction toward the cardinal and anterolateral extremities; but gently swollen between.

Ventral valve interior with strong dental plates.

Measurements (in mm).—

	dorsal length (L)	valve length	hinge width	maxi- mum width (W)	thick- ness (T)	L/W ratio	T/W ratio
USNM 200900 (Holotype; loc. 523d)	48.1	39.0	37.6	58.2	31.7	0.83	0.55
USNM 200901a (loc. 523h)	39.1	31.6	37.0	48.5	26.6	0.80	0.55
USNM 200901b	43.7	34.7	39.8	53.7	38.8	0.81	0.73
USNM 200902 (loc. 523b)	34.4	28.5	29.0	41.8	21.0	0.82	0.48
USNM 203514	44.4	35.0	38.9?	54.3	32.6	0.89	0.60
USNM 203515a (loc. 523f)	36.3	29.8	32.0	42.4	24.4	0.86	0.58
USNM 203516a (loc. 523j)	32.7	27.0	27.9	40.0	20.8	0.82	0.52
USNM 203513a (loc. 526i)	36.7	31.4	33.4	48.0	21.6	0.76	0.46

Diagnosis.—Large *Warrenella* with length about 80 percent of the width, and fine concentric lines with about 12 spines to the mm.

Stratigraphic occurrence.—Oñate Formation.

Localities.—523a, b, d, f, g, h, j, k, o, s, t; 526i.

Types.—Holotype: USNM 200900. Figured Paratypes: USNM 200901a, 200902, 201129a, b, c. Unfigured Paratypes: USNM 200901b–e, 201129d–h.

Discussion.—This species resembles *Warrenella occidentalis* (Merriam, 1940) and *W. timetea* Crickmay (1960). It differs from the former in having a less protuberant beak of the ventral valve, a deeper sulcus, stronger fold, and much wider hinge. *Warrenella magna* differs from *W. timetea* in being more transverse, in having finer concentric lines, narrower fold and sulcus, and less strongly protuberant ventral valve beak. *Warrenella franklini* (Meek, 1868) is more elongate, deeper, with a less pronounced fold, narrower sulcus, and proportionately wider hinge.

Warrenella magna is sufficiently abundant to give some idea as to how the deltidial structure forms. In the adult condition, this plate simulates a pseudodeltidium, but it is formed initially of two oblique plates on the margins of the delthyrium. The pedicle evidently was protruded near the apex of the delthyrium between these two plates. Anteriorly, these plates grew together leaving an opening for the pedicle. In time, this pedicle opening was plugged and the pedicle became no longer functional. Nearly all specimens display this plugged foramen. The deltidial structure anterior to the plug shows continuous concentric growth lines anterior to the plug, and for some distance anteriorly, similar to the henidium of Cloud (1942, p. 12).

Warrenella floweri new species

Plate 35, figures 39–54; plate 42, figure 26;
plate 43, figures 10–22

About medium-sized for genus, roundly quadrate in outline. Hinge narrower than widest part, which is at midwidth; sides broadly rounded; anterior margin truncated to slightly emarginate; ventral valve posterior moderately protuberant beyond the dorsal umbo; interarea moderately long, curved, orthocline to apsacline. Valves unequally deep, ventral valve much deeper than dorsal one; anterior commissure unipli-cate. Surface marked by closely crowded concentric lines bearing minute single-barreled spines, about 14 to the mm.

Ventral valve with fairly strongly convex lateral profile and a strongly curved umbonal region; anterior profile strongly convex and with median region depressed by sulcus. Flanks bounding sulcus inflated; sulcus originating about ten mm anterior to beak, widening and deepening anteriorly to occupy somewhat less than half midwidth. Tongue moderately long and narrowly rounded.

Dorsal valve gently convex in lateral profile, most convex in posterior half; anterior profile broadly convex, fold not affecting median region; flanks gently inflated, sloping moderately. Umbonal region slightly swollen; median region moderately inflated; fold scarcely visible posterior to midvalve, low and gently rounded in anterior third.

Ventral valve interior having small teeth, thin but strong, subparallel dental plates; muscle area narrow, partially enclosed by dental plates.

Measurements (in mm).—

	dorsal length	valve length	hinge width	mid- width	thick- ness
USNM 200883b (Holotype; loc. 523o)	31.9	25.6	25.6	33.3	21.8
USNM 200883a	22.3	23.4	23.3	34.3	20.0
USNM 200883c	30.0	24.0	27.2	33.6	20.6
USNM 200883d	26.6	22.6	20.6	30.5	16.9
USNM 200883e	33.0	26.0	33.8	40.4	24.3
USNM 200883f	8.0	7.1	6.0?	9.4	4.6
USNM 200923a (loc. 524x)	27.8	22.6	25.7	32.6	20.4
USNM 200923b	31.5	25.2	27.0	36.0	21.5
USNM 200923c	30.0	23.6	26.4	33.2	22.8

Diagnosis.—Medium-sized, wide-hinged *Warrenella* with rotund appearance and fold conspicuous only at anterior.

Stratigraphic occurrence.—Oñate Formation.

Localities.—506d; 523e, i, k, o; 524x.

Types.—Holotype: USNM 200883b. Figured Para-

types: USNM 200883a, c, d, 200923a. Unfigured Paratypes: USNM 200883e–f, 200923b–d.

Discussion.—*Warrenella eclectea* Crickmay (1953), type species of the genus, is of about the same size as that of *W. floweri* n. sp., but it has narrowly rounded sides, a more pronounced fold and sulcus, and more sharply defined ridges bounding the sulcus on the ventral valve. *Warrenella floweri* differs from *W. labrequiei* Crickmay (1960) in having less narrowly rounded sides, narrower hinge, more truncated anterior, shorter interarea, and a more rounded, less protuberant beak.

Formerly, *Warrenella floweri* was common at the Nackaye “Paint Mine” near Nackaye mine in the Caballos Mountains. The specimens came from a temporary excavation and are not now so abundant. The species is rare in the Mud Springs Mountains west of Truth-or-Consequences, New Mexico.

For a discussion of species of *Warrenella* and their stratigraphic meaning, see Ludvigson and Perry (1975).

Genus **TORYNIFERELLA** Weyer, 1967

Toryniferella spinosa (Kindle)

Plate 42, figures 1–10

Reticularia spinosa Kindle, 1909, p. 27, pl. 9, figs. 7–9a.
Torynifer spinosus (Kindle) Stainbrook, 1947, p. 325, pl. 47, figs. 38–42.

Stainbrook (1947) referred this species to *Torynifer* but it lacks the median septum and apical chamber characteristic of *Torynifer*.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, a, b, p, q; 507a, c, d, h, k, m, o, u, z; 509a, b, c, e; 527d, e, f, g; 3026, a; 3029; 3034; 3035; 3042, s; USGS 508, 512.

Types.—Holotype: USNM 62034. Figured Paratype: USNM 62035, primary types figured by Kindle (1909). Hypotypes figured by Stainbrook (1947): M.A.S. 1589A (=USNM 155774); M.A.S. 1589B (=USNM 155775); M.A.S. 1589C (=USNM 155776).

Family **ELYTHIDAE** Fredericks, 1919 (1924)

Genus **ELITA** Fredericks, 1918

Elita magister new species

Plate 36, figures 45–55

Not Elytha diversa Stainbrook, 1948, p. 777, pl. 2, figs. 21, 22.

Large, subrectangular in outline, subequivalve, ventral valve slightly deeper. Sides strongly rounded; anterior margin truncated. Anterior commissure strongly uniplicate. Beak small, incurved. Interarea long, nearly flat, strongly apsacline. Fold and sulcus without costae; flanks costate, costae low and broad, separated by narrow interspaces; six or seven costae on each flank.

Ventral valve gently convex in lateral profile but with umbonal region more strongly convex than rest of profile; anterior profile moderately and broadly convex, median region narrowly depressed by sulcus. Umbonal region narrowly swollen; posterolateral slopes rounded and descending steeply to margins. Sulcus originating on umbo near beak, deepening anteriorly and occupying nearly half valve width. Flanks bounding sulcus moderately inflated. Tongue long and narrowly rounded. Delthyrium bounded by narrow, obliquely elevated deltidial plates.

Dorsal valve gently convex in lateral profile except for the umbonal region, which is more narrowly rounded; anterior profile a broad dome, narrowly elevated medially where fold is located. Umbonal and median regions swollen. Fold originating on umbo, poorly defined for one-third of its distance anteriorly, elevated moderately at midvalve and prominent at anterior, where its width is one-third or somewhat less of valve width. Fold narrowly rounded. Flanks gently swollen and depressed well below fold anterior to midvalve.

Ventral valve interior having strong and long dental plates and a median septum that fails to reach the apex.

Measurements (in mm).—

	length (L)	dorsal valve length	maximum width (W)	hinge width	thickness (T)	L/W ratio	T/W ratio
USNM 203518 (loc. 506j)	22.0	19.0	26.0	17.5	14.2	0.84	0.55
USNM 203517a (loc. 509z)	16.1	15.5	18.3	11.2	10.1	0.88	0.56
USNM 203517b	24.1	22.5	30.0	17.9	18.2	0.80	0.61
USNM 203519 (loc. 523m)	24.1	20.8	27.8	14.7	16.5	0.85	0.59
USNM 200906 (Holotype; loc. 524m)	26.8	23.7	30.1	16.9	19.6	0.89	0.65
USNM 200907a (loc. 524n)	28.2	23.3	36.6	26.7	22.0?	0.77	0.60
USNM 200907b	30.0?	26.0?	38.0	22.8	25.6	0.79	0.68

Diagnosis.—Large moderately transverse *Elita* with the fold scarcely visible on the umbo and broad costae.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506c, j; 509s; 521d, m, q; 523m; 524m, n; 529s; USGS (Kirk) 536; 3054i.

Types.—Holotype: USNM 200906. Figured Paratype: USNM 200907.

Discussion.—Compared to specimens of *E. inconsueta* (Fenton and Fenton, 1924) the New Mexico species attains a much larger size, has a narrower and less protuberant ventral umbo, and has stronger costae. *Elita magister* resembles *E. diversa* Stainbrook (1948) but it is larger, less transverse, and has a more elevated beak than the Independence species. The specimen figured by Stainbrook (1948, pl. 2, fig. 21 [USNM 135279]) is an immature specimen in which the costae have not yet formed.

Elita magister is a rare species in the Sly Gap Formation and most of the specimens come from the San Andres Range.

Family MARTINIIDAE Waagen, 1883

OIOSIA new genus

[Greek *oios* = peculiar]

Small, unequally biconvex, ventral valve having greater depth than dorsal valve; hinge narrower than maximum width; interarea narrow, delthyrium wide, partially closed by apical plate. Anterior commissure uniplicate. Fold and sulcus non-costate; flanks marked by low rounded costae, often only faintly visible. Microsculpture consisting of mat of minute spines or papillae that leave a pitted surface where stripped from the external layer.

Ventral valve interior with small teeth and long, thin dental plates. Myophragm in old shells. Dorsal valve interior having narrow sockets bounded by thin and delicate socket ridges that lack supports. Spire loosely coiled, six volutions on a side.

Type species.—*Brachythyris putilla* Stainbrook, 1947, p. 322, pl. 47, figs. 24–28.

Diagnosis.—Small martiniids having long dental plates and matted papillae on exterior.

Comparison.—The presence of dental plates in the ventral valve and absence of strong costae on the fold and sulcus effectively separate Stainbrook's species from *Brachythyris* M'Coy (1844). The nearest described genus is *Eobrachythyris* Brice (1970) which possesses dental plates and an apical plate, both of which are present in the Percha genus. *Oiosia* n. gen. differs from *Eobrachythyris* in its microsculpture, the non-costate fold and sulcus, subdued costation, closely disposed dental plates and shell form. Species described and mentioned by Brice are strongly costate

and one of them is rather mucronate and thus entirely unlike the Percha genus. This genus is suggestive of *Eomartiniopsis* Sokolskaya (1941), but there are no septal plates in *Oiosia* as required by Sokolskaya's description, and the exterior is papillose, not pitted as in the Russian genus.

Oiosia putilla (Stainbrook)

Plate 9, figures 10–13; plate 36, figures 56–60; plate 37, figures 42–65; plate 42, figures 11–25; plate 44, figures 27–35

Brachythyris putilla Stainbrook, 1947, p. 322, pl. 47, figs. 24–28.

A very rare species at all Percha exposures but geographically widely represented.

Stratigraphic occurrence.—Percha Formation (Box Member).

Localities.—506, a, b, p, q; 507b, h, o; 509a, b, e; 527d, e; 3026a; 3042s.

Types.—Holotype: M.A.S. 1585A (=USNM 155797). Unfigured Paratypes: M.A.S. 1585 (=USNM 155798). Figured Hypotypes, herein: USNM 200975, 200976, 200977b, e, 201144, 201145a, 204955a, 204956.

Superfamily CYRTINACEA Fredericks, 1912

Family CYRTINIDAE Fredericks, 1912

Genus CYRTINA Davidson, 1858

Cyrtina inulta Stainbrook

Plate 37, figures 1–35

Cyrtina inulta Stainbrook, 1945, p. 59, pl. 6, figs. 26–29; 1948, p. 778, pl. 2, figs. 17–20.

About medium-sized, transversely rectangular in dorsal view, hemipyramidal in lateral view; hinge width less than or equal to maximum width; cardinal extremities obtusely rounded to acute. Anterior commissure strongly uniplicate, sides varying from moderately rounded to nearly straight and oblique to midvalve; interarea long, varying from moderately curved and apsacline to nearly flat and catacline. Beak sharp, occasionally twisted. Deltidium narrow and moderately convex; foramen apical, often long. Surface costate, costae strongly rounded and separated by spaces about equal in width to width of costae; about five to seven costae on a side. Entire surface covered by fine granules or spines that are seldom preserved and usually seen only with difficulty.

Ventral valve in lateral profile forming an angle of 50° to 60°, the lower side of the triangle gently convex; anterior profile moderately domed but with deep median depression representing sulcus. Flanks gently swollen and steep. Sulcus originating at beak, deepening and widening anteriorly to occupy one-third to one-half shell width. Tongue moderately long and sharply rounded.

Dorsal valve evenly and gently convex in lateral profile but very broadly and gently convex in anterior profile; fold originating at beak, widening anteriorly and sharply set off from flanks by deep grooves; flanks flatly convex.

Dorsal valve interior with a long and spreading cardinal process.

Measurements (in mm).—

	length (L)	dorsal valve length	hinge width	mid- width (W)	thick- ness	L/W ratio
USNM 201068a (loc. 506c)	12.0	10.5	16.0	16.0	13.0	0.75
USNM 201068b (loc. 506c)	9.1	9.9	14.7	14.2	12.1	0.64
USNM 201068c (loc. 506c)	10.0	8.4	11.1	12.6	9.0	0.79
USNM 201068d (loc. 506c)	7.1	7.6	10.5	12.4	10.2	0.57
USNM 201068e (loc. 506c)	7.9	7.9	17.6*	12.6	11.0	0.63

Diagnosis.—Small to medium *Cyrtina* with five to seven costae on each side, a narrowly rounded fold often with slight median depression posteriorly, and a broad, spreading, four-pronged cardinal process.

Stratigraphic occurrence.—Sly Gap Formation; Contadero Formation.

Localities.—Sly Gap: 506c, i, j, v; 509g, h, i, j, l, n, o, p, s, v, x, y; 521c, d, e, k, l, o, q, r, t; 522k, u, y; 524m, n, y; 526k, m, n, q; 529s; 3054b. Contadero: 526g.

Types.—Figured Hypotypes: USNM 201068a–f.

Discussion.—Like most species of the genus, this one is quite variable but seems, nevertheless, to conform well with Stainbrook's illustrated specimens. Some of the specimens are larger than those recorded by Stainbrook. The species is commonest in the Sacramento Mountains, especially at the Indian Wells Canyon locality (506c).

***Cyrtina variabilis* new species**

Plate 37, figures 36–41; plate 38, figures 1–12

Small for the genus, wider than long, subrectangular in dorsal view, subpyramidal in lateral view; anterior commissure broadly uniplicate; sides nearly straight and subparallel, anterior margin broadly rounded; hinge about equal to midwidth and with small cardinal points. Interarea fairly long, curved and catacline. Surface costate, costae and interspaces of about equal width; six or seven costae on a side. Sulcus broad and shallow, occupying 40 percent of the valve width; tongue short and rounded. Fold originating at the beak, low and broadly rounded. Deltidium fairly wide and with

the foramen occupying about 60 percent of its length. Interior not seen.

Measurements (in mm).—USNM 201270: length 8.7, dorsal valve length 7.2, hinge width 9.0, midwidth 9.7, thickness 7.0.

Diagnosis.—Small *Cyrtina* with six or seven costae on a side, a broad low fold and shallow sulcus, fairly wide deltidium with foramen occupying 60 percent of its length.

Stratigraphic occurrence.—Oñate Formation.

Localities.—522o; 523d, f, i, o, t; 524a, d; 526c; 528n; 3023c; 3052a.

Types.—Holotype USNM 201270; Figured Paratypes: USNM 201271, 203558.

Discussion.—We have assigned specimens from 12 localities to this species. Each specimen has its own peculiarities but the variability seems consistent with that seen in other species, *Cyrtina inulta* Stainbrook (1947), for example. Specimens from the "Paint Mine" at Nackaye Mountain (523o) are extremely variable, no two seeming to be connected except generically, but all having a lower, wider dorsal fold and smaller size than Stainbrook's species.

Order TEREBRATULIDA Waagen, 1883

Suborder TEREBRATULIDINA Waagen, 1883

Superfamily DIELASMATACEA Schuchert, 1913

Family CRANAENIDAE Cloud, 1942

Subfamily CRANAENINAE Cloud, 1942

Genus CRANAENA Hall and Clarke, 1893

***Cranaena calvini* (Hall and Whitfield)**

Plate 38, figures 44–53

Cryptonella eudora Hall and Whitfield, 1873, p. 225.

Cryptonella calvini Hall and Whitfield, 1873, p. 239.

(?) *Dielasma calvini* (Hall and Whitfield) Hall and Clarke, 1893, p. 296 (not pl. 80, figs. 20–22).

Cranaena calvini (Hall and Whitfield) C. L. Fenton, 1919, p. 372; Belanski, 1928, p. 17, pl. 3, figs. 1–7; Cloud, 1942, p. 135; Stainbrook, 1945, p. 46, pl. 4, fig. 35.

Cranaenella calvini (Hall and Whitfield) Fenton and Fenton, 1924, p. 132, pl. 25, figs. 23–25.

A few specimens referred to this species were taken from the Sly Gap Formation. One of the specimens (USNM 200844) exceeds the dimensions of those from the Hackberry Group of Iowa but has the same subrhomboidal form and flattened profile.

Stratigraphic occurrence.—Sly Gap Formation.

Localities.—506j; 509o, w, z; 521o, r; 524m.

Types.—Figured Hypotypes: USNM 200844a, 200845.

***Cranaena navicella* (Hall)**

Plate 38, figure 30

Terebratula navicella Hall, 1867, p. 391, pl. 60, figs. 38–44.*Centronella* (?) *navicella* (Hall) Hall and Clarke, 1895, p. 79, figs. 40–42.*Centronella navicella* (Hall) Fenton, 1919, p. 372.*Cranaenella navicella* (Hall) Fenton and Fenton, 1924, p. 130, pl. 25, figs. 18–22.

A single specimen, somewhat larger than normal but with subcarinate dorsal valve, is referred to this Hackberry form. The specimen comes from the Rhodes Canyon Formation at locality 528j.

Types.—Figured Hypotype: USNM 203564.

***Cranaena* species 1**

Plate 39, figures 27, 28

Three specimens of *Cranaena* were taken from the Oñate Formation at localities 522f, 529k, and 3023c, the largest one from the former locality. The specimens are of about average size for the genus. The largest one is somewhat rhomboidal in outline, with the maximum width at midvalve. The anterior margins taper to a narrowly rounded extremity. The posterior margins form an angle of 90°. The valves are nearly equally, but gently, convex. The largest specimen resembles *Cranaena amana* Stainbrook and *C. calvini* (Hall and Whitfield) from the Hackberry Formation, but it is more tapering anteriorly than either of those species.

Measurements (in mm).—USNM 207694: length 19.1, midwidth 18.2*, thickness 8.0.

Types.—Figured Specimen: USNM 207694.

***Cranaena* species 2**

A small, probably immature, *Cranaena* was found at Indian Wells Canyon, locality 506c. The specimen is somewhat suggestive of *C. navicella* (Hall, 1867), but its obvious immaturity makes a positive specific identification impossible.

Types.—Mentioned Specimen: USNM 207702.

Family **HETERELASMINIDAE** Licharew, 1956

Genus **AFILASMA** Stehli, 1961

Afilasma inexpectatum new species

Plate 38, figures 32–43; plate 44, figures 36–47

Near average size for a heterelasminid brachiopod (nearly 25 mm in length), subequally biconvex, longitudinally elliptical in outline; sides broadly rounded; anterior margin slightly rounded to truncate. Anterior commissure rectimarginate. Lateral commissure nearly straight. Beak erect, short, labiate and with a large submesothyridid foramen. Surface marked only by concentric lines of growth.

Ventral valve of about equal depth to that of dorsal valve, moderately and evenly convex in lateral profile; moderately domed in anterior profile, with short steep sides. Umbonal region narrowly swollen, the swelling reaching maximum at about midvalve then declining anteriorly to form a long gently curved, moderately steep anterior slope.

Dorsal valve gently convex in lateral profile, somewhat narrowly domed in anterior profile, more so than ventral valve. Median region swollen; umbonal region gently convex; anterior slope moderately steep.

Ventral valve interior with widely divergent dental plates. Dorsal valve with long diverging inner hinge plates reaching nearly one-third dorsal valve length.

Measurements (in mm).—

	length	dorsal valve length	maxi- mum width	thick- ness	apical angle
USNM 200930 (loc. 509u)	23.4	20.6	16.5	12.2	58°
USNM 203530 (Holotype; loc. 528a)	20.6	18.2	13.9	11.2	60°

Diagnosis.—Elongate, rectimarginate *Afilasma* with the width about two-thirds of the length.

Stratigraphic occurrence.—Rhodes Canyon Formation; Contadero Formation.

Localities.—Contadero Formation: 509u; 528a. Rhodes Canyon Formation: 523v.

Types.—Holotype: USNM 203530. Figured Paratype: USNM 200930.

Discussion.—This species differs strongly from *Afilasma beecheri* Stehli (1961) from the Chemung at Hornellsville, New York. The New Mexico species is smaller, has longer inner hinge plates, is more slender, and has gently convex lateral margins. *Afilasma inexpectatum* is a very rare fossil, only three specimens having been found.

***Afilasma* species**

Plate 38, figure 31

Two specimens of another species of *Afilasma* were taken from the Thoroughgood Formation, but they are too poor for naming. The best specimen indicates a species larger than *A. inexpectatum*, having a length of 28 mm and a width of 20 mm. The specimen is more expanded anteriorly and less convex than the Rhodes Canyon species, but it has the same elongated and divergent inner hinge plates in the dorsal valve and short divergent dental plates in the ventral valve.

Locality.—522.

Types.—Figured Specimen: USNM 200995b.

Comparison.—This species differs from *A. beecheri* Stehli (1961) in its outline although it is about the same size. Because *Afilasma* sp. tapers posteriorly and ex-

pands anteriorly, it is quite different from *A. inexpectatum* from the Contadero and Rhodes Canyon formations.

CLARIFICATION OF TAXONOMIC AND STRATIGRAPHIC
PROBLEMS RAISED BY STAINBROOK'S 1947
PAPER ON THE PERCHA BRACHIOPODS

Recurrent misinterpretations of the age of the Percha Formation stem from Stainbrook's assessment of a few brachiopod taxa. During this study, we examined all specimens upon which Stainbrook based his conclusion that the Percha fauna was of Mississippian age. We discuss each suspect taxon below.

Dielasma coreiforme (Stainbrook 1947, p. 318, pl. 47, figs. 34–37) is placed in the synonymy of *Composita bellula* Stainbrook (1947) because it has an impunctate shell and the form of a young specimen of *C. bellula*. No unequivocal terebratulaceans have yet been found in the Box Member of the Percha Formation.

Locality.—Hillsboro (Stainbrook 1947, p. 318).

Types.—M.A.S. 1618 (=USNM 135262).

Leptaena analoga [Stainbrook (*not* Phillips, 1836), 1947, p. 304] was collected by Kindle (1909, p. 16) as well as by Stainbrook, who said that his specimens were demonstrably from the overlying Mississippian Lake Valley Formation. Examination of Kindle's specimen of *Leptaena* (USNM 62004) suggests that it, too, came from the Mississippian. The specimen is occupied by a crinoid holdfast, unlikely for a Percha specimen because Percha echinoderms are extremely rare. Collecting by National Museum of Natural History parties over some 20 years failed to locate a *Leptaena* unequivocally in place in Upper Devonian beds. However, float specimens from the overlying Mississippian strata are frequently encountered.

Buxtonia singularis (Stainbrook 1947, p. 314, pl. 46, figs. 1, 2) is of questionable position for two reasons: first, its collecting locale is the outcrop of Rhodes Canyon Formation (not Percha) in Rhodes Pass; second, it appears to be a Pennsylvanian *Linoproductus* Chao (1927). The flattish dorsal valve, large spine bases on the ears, lack of dorsal spines, and an extremely small beak that could not have accommodated the large curved cardinal process of *Buxtonia* Thomas (1914), all point to *Linoproductus*.

Stratigraphic occurrence.—Float from Pennsylvanian strata at locality near entrance to Rhodes Pass.

Types.—Holotype: USNM 135253.

Shumardella glabraventra (Stainbrook 1947, p. 317,

pl. 47, figs. 14–18). Stainbrook described this species as coming from the Percha Formation at Hillsboro, New Mexico, and from east of Rhodes Pass. The specimen is not *Shumardella* Weller (1910), a Mississippian genus, but belongs to a rare species of *Evanes-cirostrum* Sartenauer (1965) and comes from the Rhodes Canyon Formation.

Types.—Holotype: M.A.S. 1587 (=USNM 135258; not figured herein).

Cyrtospirifer breviposticus (Stainbrook 1947, p. 320, pl. 44, figs. 3–6). Stainbrook's type specimen is said to come from the Percha Formation in Rhodes Pass. There is no Percha in Rhodes Pass. The specimen comes from the Rhodes Canyon Formation and is described herein.

Brachythyris bisbeensis (Stainbrook 1947, p. 321, pl. 47, figs. 23, 29, 30) is definitely not a *Brachythyris* M'Coy (1844) because it has dental plates, barely visible on the shell surface. The specimen shows no micro-ornament and, thus, is difficult to relate to *Indo-spirifer* Grabau (1931), which has never been found in the Percha. The specimen may be a small *Anthraco-spirifer* Lane (1963), possibly related to *A. rockymontana* (Marcou, 1858) from the Pennsylvanian.

Locality.—Mount Martin, near Bisbee, Arizona.

Types.—Holotype: USNM 135256.

Tylothyris novamexicana (Stainbrook 1947, p. 323, pl. 47, figs. 31–33) is another species said to come from the Percha Formation in Rhodes Pass. There is no Percha Formation in Rhodes Pass; this species, actually from the Rhodes Canyon Formation, is described herein.

Types.—Holotype: M.A.S. 1620 (=USNM 135263).

Cleiothyridina reticulata (Stainbrook 1947, p. 326, pl. 45, figs. 31–35) is another species said to come from the non-existent Percha Formation in Rhodes Canyon. It is actually from the Rhodes Canyon Formation and is made the type species of *Crinisarina*, described herein.

Types.—Holotype: M.A.S. 1588a (=USNM 135249); Paratype: M.A.S. 1588b (=USNM 135249b).

Rhipidomella manticula [Stainbrook 1947, p. 303, pl. 45, figs. 3, 5, 6 (*not* fig. 4 = *Thiemella platys* n. sp.)]. Three specimens from the Rhodes Canyon Formation are more properly referred to *Aulacella* Schuchert and Cooper (1931) and are described herein as *Aulacella manticula* (Stainbrook). The fourth specimen, from the Box Member of the Percha Formation, is described herein as *Thiemella platys* n. sp.

APPENDIX 1

LOCALITY LISTS (GEOGRAPHIC)

List of Localities in New Mexico

Agua Chichita Canyon: 529m
 Alamo Canyon: 509i, y; 521p; 524; 526k, m, n; 528u, w; 529j, n.
 Alamo Peak: 506s; 509g, k, v; 522d, e, i; 524, g, h, i, j, k, l; 528x; 3053.
 Arcente Canyon: 509m; 521n; 529w; 3045.
 Ash Canyon: 523p, q; 524m; 528r.
 Bear Canyon: 529t.
 Bear Mountain: 506q; 507j, k, l, m, p, r; 509a, b, e; 527a, b, e, l, m, n, o, p; 3042, s.
 Caballero Canyon: 509l.
 Capitol Peak: 521u, w, x, y, z; 526s; USGS 538, 540.
 Chise: 529y.
 Chloride Flat: 509; 527g.
 Deadman Canyon (Sacramento Mountains): 521o; 524a; 526f, p, v; 529k; 3013.
 Deadman Canyon (San Andres Mountains): 521s; 523y; 524s; 526a; 528y; 529q, s, u.
 Derry Hills: 506u; 522p, q; 523b, f; 526j.
 Dog Canyon: 524b, d.
 Dry Canyon: 524y.
 Escondido Canyon: 523w, x, z; 524f.
 Georgetown: 506, a; 507b.
 Hembrillo Canyon: 524o, u; 527q; 528b.
 Hembrillo Gap: USGS 541.
 Hermosa: 526b, c, d; 527w, x; 528i, k, n, p; 529p.
 Hillsboro: 507h; 527j; 3025a; 3034; USGS 461.
 Indian Wells Canyon: 506c, v; 507; 509n; 529x.
 Johnson Park Canyon: 526z; 528t; 529g, i; 3023, a-d.
 Kingston: 507d, e, f, i, n, t, u, v, w, x; 509d; 3035; USGS 460; 4804.
 Lake Valley: 527c, i; USGS 512.

Lava Gap: 509z.
 Lost Canyon: 528i.
 Marble Canyon: 506i; 509j; 526q, r; 529o, r.
 Mud Springs Mountains: 506d, e, y; 509f; 521v; 522f, g, h, j, k, l, n, o, u, v, w, x, y, z; 523c, e, i; 524p, r; 526l; 528e.
 Mule Canyon: 509h, ha; 521c.
 Nackaye Mine: 506r, t; 522p, q; 523d, j, k, o; 524x; 526e, i; 529l.
 Nunn Ranch: 527k; 3029.
 Percha Creek: 506p; 507g; 3031.
 Pig Canyon: 509w, x; 521l; 526h, o; 3052a.
 Red House Mountain: 523g, h.
 Rhodes Canyon: 506w, x; 509p, r, t, u; 521e, f, g, h, i, j; 522a, b, c, m; 523l, m, v; 524e, t, v, z; 526g, x; 527t, u, z; 528a, c, j, q, s; 3045; 3054, b, c, f-i, k, q.
 Rincon: 522r, s; 523a.
 San Andres Canyon: 523r, s, t, u; 524q; 529v; USGS 536.
 Santa Rita: 506b; 507a, c, o, s, z; 527f; 3043; USGS 459.
 Sawpit Canyon: 507y.
 Sheep Mountain: 506j; 509o, q, s; 521d, k, m, q, r, t; 522; 523n; 524c, n; 527r, v; 528g, o, v; 3016; USGS 534.
 Sierra Caballo Mountains fault: 522t; 524w.
 Sly Gap: 521d.
 Sulphur Gap: USGS 534.
 Tierra Blanca Creek: 507q; 3029.
 Trujillo Creek: 3030.
 Wilson Ranch: 509c; 527d, h; 3026, a; 3037.

List of Localities in Iowa

Independence Shale: 362a, b; 526t, u, w, y; 527s, y; 528d, f, h, l, m, p.
 Hackberry Formation: 527y; 528d.

APPENDIX 2

LOCALITY LISTS (STRATIGRAPHIC)

Oñate Formation: 506d, r, t, u; 521z; 522c-j, l-v, z; 523a, b, d-k, o, s-u, w-z; 524a, b, d, f-l, p-r, x; 526b, c, h-j, o, p, v, z; 527u, w, x; 528e, i, k, n, s, t, u; 529g, j, k-o, q, r, t, w; 3013; 3023; 3025a, c; 3053; USGS 540.
 Sly Gap Formation: 506c, e, i, j, s, v, y; 507; 509f, g, h, ha, i-s, v-z; 521c, d, e, k-y; 522b, k, w-y; 523c, m; 524m, n, u, v, w, y; 526d-f, k-n, q-s, x; 527r, t; 528p, r, v-y; 529i, p, s, u, v, x, y; 3016; 3025; 3045b, c, g; 3054b, c, f-i.

Contadero Formation: 506w, x; 509t; 521f, j; 522a; 523l, n, q, r; 524c, o, oa, s, t; 526a, g; 527q, v; 528a, b, g, j, o, q; 3054k.
 Rhodes Canyon Formation: 509u; 521g-i, 523p, v; 524e, z; 527z; 528c, j; 3054q.
 Thoroughgood Formation: 522.
 Percha Formation (Box and Ready Pay members): 506, a, b, p, q; 507a-z; 509, a-e; 527a-p; 3026, a; 3039; 3030; 3031a, b; 3034; 3035; 3037; 3042, s; 3043; USGS 459; 460; 461; 508; 509; 510; 512; 4804.

APPENDIX 3

LOCALITY DESCRIPTIONS AND FAUNAL LISTS

362a. Independence Formation

On Iowa Highway 220, 0.3 mile west of Middle Amana, Iowa.

Coeloterorhynchus schucherti (Stainbrook) (not found in New Mexico)

Floweria transversalis new species

Nervostrophia extensa new species

Schizophoria amanaensis Stainbrook

Spinatrypa trulla (Stainbrook)

362b. Independence Formation

West Amana, Iowa. Collector: M. A. Stainbrook.

Schizophoria amanaensis Stainbrook

506. Percha Formation (Box Member)

Ravine just north of hairpin turn of road on west edge of Georgetown, SE¼SE¼ sec. 1, T. 17 S., R. 12 W., Santa Rita (7½') quadrangle, New Mexico. Collectors: J. Bridge and G. A. Cooper.

Acanthatia nupera (Stainbrook)

Athyris transversa (Stainbrook)

Composita bellula Stainbrook

Cyrtiorina kindlei (Stainbrook)

Cyrtospirifer convexus new species

C. rotundus new species

506. (continued)

Galeatella galeata Muir-Wood and Cooper
Hispidaria spinosa new species
Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Petrocrania ourayensis (Kindle)
Planoproductus hillsboroensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Retichonetes obscurus new species
R. perchaensis new species
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Sentosia praecedens (Stainbrook)
S. spinigera (Kindle)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Thiemella platys new species
Toryniferella spinosa (Kindle)

506a. Percha Formation (Box Member)

1.4 miles east of hairpin bend in west edge of Georgetown, and about ¼–½ mile south of Georgetown, Silver City (30') quadrangle, New Mexico. Collectors: J. Bridge and G. A. Cooper.

Acanthatia nupera (Stainbrook)
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer convexus new species
Galeatella galeata Muir-Wood and Cooper
Leioproductus varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Planoproductus hillsboroensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)

506b. Percha Formation (Box Member)

North side of New Mexico Highway 180, about center W½NE¼ sec. 20, T. 17 S., R. 11 W., 3.25 miles east of Santa Rita, Santa Rita (7½') quadrangle, New Mexico.

Acanthatia nupera (Stainbrook)
Athyris transversa (Stainbrook)
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer rotundus new species
Galeatella galeata Muir-Wood and Cooper
Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Lingula species 1
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria multicostata new species
P. patens new species
Planoproductus hillsboroensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)

Retichonetes obscurus new species
R. perchaensis new species
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Sentosia praecedens (Stainbrook)
S. spinigera (Kindle)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)
Trifidorostellum obscurum new species

506c. Sly Gap Formation (mostly upper)

Indian Wells Canyon, NW¼SW¼NW¼ sec. 14, T. 16 S., R. 10 E., 3 miles due east of School for Blind at north edge of Alamogordo, Otero County, Sacramento Mountains, New Mexico.

Acutatheca prolifica new species
Aulacella elliptica new species
Calvinaria bransoni Stainbrook
Cariniferella allenii new species
Coeloterorhynchus magnificum new species
Costatrypa extensa new species
C. varicostata (Stainbrook)
Cranaena species 2
Cyrtina inulta Stainbrook
Devonoproductus intermedius new species
D. vulgaris Stainbrook
Douvillina arcuata (Hall)
D. minuta new species
D. parviuscula new species
D. species 1
Douvillinaria diversa new species
D. variabilis (Calvin)
Elita magister new species
Floweria prava (Hall)
Gypidula bowscheri new species
G. mimica new species
Hyborhynchella bransoni Cooper
Hypothyridina emmonsii rotunda new subspecies
Indospirifer exfoliata new species
Nervostrophia extensa new species
N. geniculata new species
N. multinervosa Stainbrook
N. cf. N. multinervosa Stainbrook
N. solida new species
Petrocrania specifically unidentified
Productella rugatula Stainbrook
Pseudoatrypa devoniana (Webster)
Pseudodouvillina euglyphea Stainbrook
Schizophoria amanaensis Stainbrook
S. iowensis (Hall)
Skenidium independense Stainbrook
Spinatrypa trulla decorticata new subspecies
Strophonelloides parvulus new species
Sulcatostrophia calvini (Miller)
Thomasaria warreni new species

506d. Oñate Formation

Sec. 24, T. 13 S., R. 5 W., Mud Springs Mountains, west of Truth-or-Consequences, Sierra County, New Mexico. Collector: Carl C. Branson (=loc. 522f).

Desquamatia costata new species
Hypothyridina species
Morphorhynchus varicostatum new species
Schizophoria lata Stainbrook
Warrenella floweri new species

506e. Sly Gap Formation

(same as locs. 506d and 506y).

Costatrypa varicostata (Stainbrook)*Thomasaria demissa* new species

506i. Sly Gap Formation

South side of Marble Canyon, one mile east of mouth, NW¼ sec. 26, T. 16 S., R. 10 E., east of Alamogordo, New Mexico. Collectors: C. C. Branson, E. L. Yochelson, and G. A. Cooper.

Acutathea prolifica new species*Ambocoelia* species 1*Calvinaria bransoni* Stainbrook*Cariniferella alleni* new species*Coeloterorhynchus magnificum* new species*Cyrtina inulta* Stainbrook*Douvillina parviuscula* new species*Floweria prava* (Hall)*Gypidula bowsheri* new species*Hyborhynchella bransoni* Cooper*Hypothyridina emmonsii rotunda* new subspecies*Petrocrania* specifically unidentified*Pseudodouvillina euglyphea* Stainbrook*Schizophoria amanaensis* Stainbrook*Spinatrypa trulla decorticata* new subspecies*Strophonelloides parvulus* new species*Thomasaria warreni* new species

506j. Sly Gap Formation

Type section of Sly Gap Formation, south end of Sheep Mountain on north side of Sly Gap, sec. 25, T. 11 S., R. 5 E., San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collectors: C. C. Branson, E. L. Yochelson, and G. A. Cooper (=loc. 521d).

Aulacella elliptica new species*Calvinaria bransoni* Stainbrook*Coeloterorhynchus magnificum* new species*Costatrypa extensa* new species*C. varicostata* (Stainbrook)*Cranaena calvini* (Hall and Whitfield)*Cyrtina inulta* Stainbrook*Devonoproductus intermedius* new species*Douvillina parviuscula* new species*Douvillinaria diversa* new species*Elita magister* new species*Floweria prava* (Hall)*Gypidula bowsheri* new species*Hypothyridina emmonsii rotunda* new subspecies*Indospirifer anomala* new species*Iowatrypa rara* new species*Nervostrophia mucrospina* new species*Philhedra* species*Pseudotrypa devoniana* (Webster)*Rhipidomella* species 1*Schizophoria iowensis* (Hall)*Spinatrypa trulla decorticata* new subspecies*Strophonelloides parvulus* new species*Tenticospirifer* cf. *T. cyrtinaformis* (Hall and Whitfield)*Thomasaria demissa* new species*T. warreni* new species*Tylothyris sulcicostata* new species

506p. Percha Formation (Box Member)

Middle Fork of Percha Creek, NE¼ sec. 13, T. 16 S., R. 9 W., one mile west of Kingston, Hillsboro (15') quadrangle, New Mexico.

Acanthatia nupera (Stainbrook)*Athyris transversa* (Stainbrook)*Composita bellula* Stainbrook*Cyrtiorina kindlei* (Stainbrook)*Cyrtospirifer convexus* new species*Galeatella galeata* Muir-Wood and Cooper*Laminatia laminata* (Kindle)*Leioproductus plicatus* (Kindle)*L. pauperculus* new species*L. varispinosus* (Stainbrook)*Oiosia putilla* (Stainbrook)*Paurorhyncha cooperi* Stainbrook*Petasmaria patens* new species*Ptychomalotoechia sobrina* (Stainbrook)*Retichonetes obscurus* new species*Schizophoria australis* Kindle*Sentosia praecedens* (Stainbrook)*S. spinigera* (Kindle)*Strophopleura notabilis* (Kindle)*Syringospira prima* Kindle*Toryniferella spinosa* (Kindle)*Trifidorostellum obscurum* new species

506q. Percha Formation (Box Member)

Bear Mountain, 6–7 miles northwest of Silver City, New Mexico (=loc. 507m).

Acanthatia nupera (Stainbrook)*Cyrtiorina kindlei* (Stainbrook)*Cyrtospirifer convexus* new species*C. rotundus* new species*Galeatella galeata* Muir-Wood and Cooper*Hispidaria spinosa* new species*Laminatia laminata* (Kindle)*Leioproductus pauperculus* new species*L. plicatus* (Kindle)*L. varispinosus* (Stainbrook)*Oiosia putilla* (Stainbrook)*Paurorhyncha cooperi* Stainbrook*Petasmaria patens* new species*Petrocrania ourayensis* (Kindle)*Planoproductus hillsboroensis* (Kindle)*Porostictia perchaensis* (Stainbrook)*Ptychomalotoechia sobrina* (Stainbrook)*Retichonetes obscurus* new species*Schizophoria australis* Kindle*Sentosia praecedens* (Stainbrook)*Strophopleura notabilis* (Kindle)*Syringospira prima* Kindle*Thiemella platys* new species*Toryniferella spinosa* (Kindle)*Trifidorostellum obscurum* new species

506r. Onate Formation

4 miles N. 73° E. of Derry, 0.7 mile S. 10° E. of Nackaye Mine, SE¼SW¼NE¼ sec. 28, T. 17 S., R. 4 W., Sierra County, New Mexico (=loc. 522q).

506s. Sly Gap Formation

East side of Alamo Peak, N½NE¼SE¼ sec. 25, T. 16 S., R. 10 E., east of Alamogordo, Alamogordo (15') quadrangle, New Mexico (=loc. 509k).

506t. Onate Formation

Nackaye Mine, 4 miles east of Derry, Sierra County, New Mexico (=loc. 523d [see for list]).

506u. Onate Formation

Derry Hills, ½ mile east of Derry, Sierra County, New Mexico (=loc. 523f).

506v. Sly Gap Formation

Second canyon south of Indian Wells Canyon, SE¼ sec. 14, T. 16 S., R. 10 E., 4 miles east of the railroad station in Alamogordo, New Mexico (=loc. 507).

- Acutathea prolifica* new species
- Calvinaria bransoni* Stainbrook
- Cariniferella allenii* new species
- Coeloterorhynchus magnificum* new species
- Cyrtina inulta* Stainbrook
- Hypothyridina emmonsii* *rotunda* new subspecies
- Nervostrophia solida* new species
- Pseudoatrypa devoniana* (Webster)
- Pseudodouvillina euglyphea* Stainbrook
- Spinatrypa trulla decorticata* new subspecies
- Sulcatostrophia calvini* (Miller)
- Thomasaria warreni* new species

506w. Contadero Formation

One-quarter mile north of Rhodes Canyon, SW¼ sec. 3, T. 13 S., R. 4 E., Socorro County, Black Top Mountain (15') quadrangle, New Mexico (=loc. 526g [see for list]).

506x. Contadero Formation
(same as loc. 526g).

506y. Sly Gap Formation

SW¼NE¼SE¼ sec. 24, T. 13 S., R. 5 W., ½ mile N. 45° E. of Mud Mountain (el. 5749'), Mud Springs Mountains, 3.6 miles N. 45° W. of Truth-or-Consequences, (formerly Hot Springs), Cuchillo (7½') quadrangle, New Mexico. Collectors: C. C. Branson, A. L. Bowsher, J. T. Dutro, and G. A. Cooper.

- Aulacella elliptica* new species
- Calvinaria bransoni* Stainbrook
- Coeloterorhynchus magnificum* new species
- Costatrypa varicostata* (Stainbrook)
- Thomasaria demissa* new species

507. (=loc. 506v).

507a. Percha Formation (lower Box Member)

W½NE¼ sec. 20, T. 17 S., R. 11 W., 3.2 miles each of the junction of New Mexico Hwy. 180 (90) and road to Georgetown, ¼-½ mile north of New Mexico Rt. 180, Santa Rita (7½') quadrangle, New Mexico. Collectors: A. L. Bowsher, G. A. Cooper, and J. T. Dutro (=locs. 506b, 507o).

- Acanthatia nupera* (Stainbrook)
- Athyris transversa* (Stainbrook)
- Composita bellula* Stainbrook
- Cyrtiorina kindlei* (Stainbrook)
- Galeatella galeata* Muir-Wood and Cooper
- Laminatia laminata* (Kindle)
- Leioproductus plicatus* (Kindle)
- L. varispinosus* (Stainbrook)
- Paurorhyncha cooperi* Stainbrook
- Petasmaria patens* new species
- Planoproductus hillsboroensis* (Kindle)
- Porostictia perchaensis* (Stainbrook)
- Ptychomalotoechia sobrina* (Stainbrook)
- Schizophoria australis* Kindle
- Schuchertella percha* (Stainbrook)
- Sentosia spinigera* (Kindle)
- Syringospira prima* Kindle
- Toryniferella spinosa* (Kindle)
- Trifidorostellum obscurum* new species

507b. Percha Formation (Box Member)

SE corner, SE¼ sec. 1, T. 17 S., R. 12 W., at Georgetown, Santa Rita (7½') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper (=loc. 506a).

- Athyris transversa* (Stainbrook)

Cyrtiorina kindlei (Stainbrook)

Galeatella galeata Muir-Wood and Cooper

Laminatia laminata (Kindle)

Leioproductus pauperculus new species

L. plicatus (Kindle)

L. varispinosus (Stainbrook)

Oiosia putilla (Stainbrook)

Petasmaria patens new species

Porostictia perchaensis (Stainbrook)

Schuchertella percha (Stainbrook)

Strophopleura notabilis (Kindle)

Syringospira prima Kindle

507c. Percha Formation (lower Box Member)

East of bridge on New Mexico highway 180 (90), 3.8 miles west of its junction with New Mexico highway 61, 4 miles east of Santa Rita, New Mexico. Collectors: J. T. Dutro and G. A. Cooper.

Composita bellula Stainbrook

Leioproductus pauperculus new species

L. plicatus (Kindle)

L. varispinosus (Kindle)

Lingula species 2

Paurorhyncha cooperi Stainbrook

Petasmaria patens new species

Ptychomalotoechia sobrina (Stainbrook)

Schizophoria australis Kindle

Sentosia spinigera (Kindle)

Syringospira prima Kindle

Toryniferella spinosa (Kindle)

507d. Percha Formation (Box Member)

Middle Percha Creek, NE¼ sec. 13, T. 16 S., R. 9 W., one mile west of Kingston, Hillsboro (15') quadrangle, New Mexico.

Athyris transversa (Stainbrook)

Cyrtiorina kindlei (Stainbrook)

Leioproductus plicatus (Kindle)

Paurorhyncha cooperi Stainbrook

Petasmaria patens new species

Ptychomalotoechia sobrina (Stainbrook)

Schizophoria australis Kindle

Sentosia praecedens (Stainbrook)

Strophopleura notabilis (Kindle)

Syringospira prima Kindle

Toryniferella spinosa (Kindle)

507e. Percha Formation (Box Member)

Five miles by road (New Mexico 180) southwest of Kingston, New Mexico.

Athyris transversa (Stainbrook)

Cyrtiorina kindlei (Stainbrook)

Schizophoria australis Kindle

Syringospira prima Kindle

507f. Percha Formation (big nodule zone at top of Ready Pay Member)

On New Mexico highway 180, 2 miles east of Kingston, NW corner NE¼ sec. 16, T. 16 S., R. 8 W., Hillsboro (15') quadrangle, New Mexico.

Composita bellula Stainbrook

Cyrtiorina kindlei (Stainbrook)

Leioproductus varispinosus (Stainbrook)

Paurorhyncha cooperi Stainbrook

Ptychomalotoechia sobrina (Stainbrook)

507g. Percha Formation (Box Member)

Canyon of North Percha Creek, SW corner SE¼SW¼ sec. 24, T. 16 S., R. 9 W., Hillsboro (15') quadrangle, New Mexico.

Cyrtiorina kindlei (Stainbrook)

Leioproductus plicatus (Kindle)

507g. (continued)

Paurorhyncha cooperi Stainbrook
Planoproductus hillsboroensis (Kindle)
Schizophoria australis Kindle

507h. Percha Formation (Box Member)

Type section of the Box Member, SW¼SE¼ sec. 14, T. 16 S., R. 7 W., ½ mile south of the east end of the Box Canyon, 2½ miles S. 75° E. of the center of Hillsboro, Hillsboro (15') quadrangle, New Mexico. Collectors: R. E. Grant, G. A. Cooper, and J. T. Dutro.

Acanthatia nupera (Stainbrook)
Athyris transversa (Stainbrook)
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer? animasensis (Girty)
C. convexus new species
Galeatella galeata Muir-Wood and Cooper
Hispidaria spinosa new species
Laminatia laminata (Kindle)
Leioproductus coloradensis (Kindle)
Leioproductus defessa Stainbrook
L. pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Planoproductus hillsboroensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Sentosia praecedens (Stainbrook)
S. spinigera (Kindle)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Thiemella platys new species
Toryniferella spinosa (Kindle)

507i. Percha Formation (top of Ready Pay Member or base of Box Member, nodules with *Syringospira*)

SE cor. NE¼SW¼SW¼ sec. 18, T. 17 S., R. 14 W., Silver City (7½') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Syringospira prima Kindle

507j. Percha Formation (nodular bed at top of Ready Pay or base of Box Members)

West side of Bear Mountain, SW¼SE¼SW¼ sec. 11, T. 17 S., R. 15 W., Silver City (7½') quadrangle, New Mexico. (=loc. 507p)

Syringospira prima Kindle

507k. Percha Formation (Box Member)

Same as locality 507j.

Athyris transversa (Stainbrook)
Galeatella galeata Muir-Wood and Cooper
Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)
Petasmaria patens new species
Ptychomalotoechia sobrina (Stainbrook)
Strophopleura notabilis (Kindle)
Toryniferella spinosa (Kindle)

507l. Percha Formation (Box Member) (lower hard bed to top in measured section)

Bear Mountain, SW¼SE¼NE¼SE¼ sec. 13, T. 17 S., R. 15 W., Silver City (7½') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper.

Athyris transversa (Stainbrook)
Leioproductus plicatus (Kindle)
Petasmaria patens new species
Ptychomalotoechia sobrina (Stainbrook)

507m. Percha Formation (Box Member)

SE¼ sec. 13, T. 17 S., R. 15 W., Bear Mountain, Silver City (7½') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper.

Acanthatia nupera (Stainbrook)
Athyris transversa (Stainbrook)
Cyrtospirifer convexus new species
Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Petasmaria patens new species
Petrocrania ourayensis (Kindle)
Planoproductus hillsboroensis (Kindle)
Ptychomalotoechia sobrina (Stainbrook)
Retichonetes perchaensis new species
Schizophoria australis Kindle
Sentosia praecedens (Stainbrook)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)

507n. Percha Formation (Box Member)

Middle Percha Creek, one mile west of Kingston, Hillsboro (15') quadrangle, New Mexico (=loc. 507d).

Athyris transversa (Stainbrook)
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Hispidaria spinosa new species
Leioproductus pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Petrocrania ourayensis (Kindle)
Planoproductus hillsboroensis (Kindle)
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle
Sentosia praecedens (Stainbrook)
Trifidorostellum obscurum new species

507o. Percha Formation (Box Member)

Same as localities 506b and 507a.

Acanthatia nupera (Stainbrook)
Athyris transversa (Stainbrook)
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer convexus new species
Leioproductus plicatus (Kindle)
L. varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria compacta new species
P. patens new species
Petrocrania ourayensis (Kindle)
Planoproductus hillsboroensis (Kindle)
Ptychomalotoechia sobrina (Stainbrook)
Retichonetes obscurus new species
R. perchaensis new species
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Sentosia praecedens (Stainbrook)
S. spinigera (Kindle)

507o. (continued)

Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)
Trifidorostellum obscurum new species

507p. Percha Formation (nodular bed, top of Ready Pay or base of Box Members)

Bear Mountain, SE¼ sec. 13, T. 17 S., R. 15 W., Silver City (7½') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper.

Leioproductus varispinosus (Stainbrook)
Syringospira prima Kindle

507q. Percha Formation (Box Member)

Upper Tierra Blanca Creek, Hillsboro (15') quadrangle, New Mexico (=loc. 3039). Collector: A. L. Bowsher.

Cyrtiorina kindlei (Stainbrook)
Laminatia laminata (Kindle)
Leioproductus plicatus (Kindle)
Petasmaria patens new species
Porostictia perchaensis (Stainbrook)

507r. Percha Formation (Box Member)

SE cor., NE¼SW¼ sec. 18, T. 17 S., R. 14 W., Silver City (7½') quadrangle, east of Bear Mountain, New Mexico.

Acanthatia nupera (Stainbrook)
Athyris transversa (Stainbrook)
Cyrtiorina kindlei (Stainbrook)
Petasmaria patens new species

507s. (=loc. 507a) (see for list).

507t. Percha Formation (Box Member)

1.5 miles west of Kingston at mine, Hillsboro (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Athyris transversa (Stainbrook)
Cyrtiorina kindlei (Stainbrook)
Leioproductus plicatus (Kindle)
Paurorhyncha cooperi Stainbrook
Ptychomalotoechia sobrina (Stainbrook)

507u. Percha Formation (Box Member)

Two miles west of Kingston, New Mexico. Collector: A. L. Bowsher.

Hispidaria spinosa new species
Ptychomalotoechia sobrina (Stainbrook)
Toryniferella spinosa (Kindle)

507v. Percha Formation (Box Member)

At Ranger Station, north end of trail on North Percha Creek, SE corner, SW¼ sec. 24, T. 15 S., R. 8 W., Hillsboro (15') quadrangle, New Mexico.

Cyrtiorina kindlei (Stainbrook)
Leioproductus plicatus (Kindle)
Paurorhyncha cooperi Stainbrook
Schuchertella percha (Stainbrook)

507w. Percha Formation (Box Member)

Four miles up North Percha Creek from branch of West and South Percha Creeks, Sierra County, New Mexico. Collector: A. L. Bowsher.

Leioproductus plicatus (Kindle)
Paurorhyncha cooperi Stainbrook
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle

507x. Percha Formation (Box Member—lower)

Fork of Percha Creek, center, north boundary of sec. 16, T. 16 S., R. 8 W., on New Mexico highway 180, 2 miles east of Kingston, Hillsboro (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Athyris transversa (Stainbrook)

Cyrtiorina kindlei (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Syringospira prima Kindle

507y. Percha Formation (Box Member)

Sawpit Canyon near Mud Spring, center, N½SW¼ sec. 5, T. 16 S., R. 8 W., Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Ptychomalotoechia sobrina (Stainbrook)

507z. Percha Formation (Box Member)

Road cut, 4.6 miles east of Santa Rita on New Mexico Hwy. 180, New Mexico. Collectors: J. T. Dutro and G. A. Cooper.

Composita bellula Stainbrook
Laminatia laminata (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)

509. Percha Formation (Box Member)

1.5 miles north of US highway 260 to Cliff in Chloride Flat, Silver City (7½') quadrangle, New Mexico. Collector: F. V. Stevenson.

Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Petasmaria patens new species
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)

509a. Percha Formation (Box Member)

Bear Mountain Road, south side of Bear Mountain, 6 miles northwest of Silver City, Silver City (7½'), quadrangle, New Mexico.

Acanthatia nupera (Stainbrook)
Athyris transversa (Stainbrook)
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Hispidaria spinosa new species
Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Petasmaria patens new species
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Retichonetes perchaensis new species
Schizophoria australis Kindle
Sentosa praecedens (Stainbrook)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)

509b. Percha Formation (Box Member)

South side of Bear Mountain, along Bear Mountain road, 6.5 miles northwest of Silver City, Silver City (7½') quadrangle, New Mexico.

Acanthatia nupera (Stainbrook)
Ambocoelia capillata new species
Athyris transversa (Stainbrook)
Camarotoechia? species
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer convexus new species
Galeatella galeata Muir-Wood and Cooper
Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)

509b. (continued)

Leioproductus varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Petrocrania ourayensis (Kindle)
Ptychomalotoechia sobrina (Stainbrook)
Retichonetes obscurus new species
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Sentosia praecedens (Stainbrook)
S. spinigera (Kindle)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)

509c. Percha Formation (Box Member)

0.4 mile SSE of Wilson Ranch, SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 10, T. 18 S., R. 7 W., Hillsboro (15') quadrangle, New Mexico. Collectors: F. V. Stevenson and A. L. Bowsher.

Athyris transversa (Stainbrook)
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Galeatella galeata Muir-Wood and Cooper
Leioproductus pauperculus new species
Petrocrania ourayensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle
Toryniferella spinosa (Kindle)

509d. Percha Formation (lower Box Member or uppermost Ready Pay Member—nodular zone)

On New Mexico highway 180 (90), 2 miles each of Kingston, Hillsboro (15') quadrangle, New Mexico (=locs. 507f, 507x).

Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Paurorhyncha cooperi Stainbrook

509e. Percha Formation (Box Member)

Bear Mountain road, west side of Bear Mountain, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 10, T. 17 S., R. 15 W., Silver City (7 $\frac{1}{2}$ ') quadrangle, New Mexico.

Athyris transversa (Stainbrook)
Cyrtospirifer convexus new species
Laminatia laminata (Kindle)
Leioproductus varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
P. multicostrata new species
Petrocrania ourayensis (Kindle)
Ptychomalotoechia sobrina (Stainbrook)
Retichonetes perchaensis new species
Schuchertella resupinata new species
Sentosia praecedens (Stainbrook)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)

509f. Sly Gap Formation (beds with *Thomasaria* = Bed I)

One half mile northeast of the highest peak, Mud Springs Mountains, 3.7 miles northwest of Truth-or-Consequences, New Mexico (=locs. 506y; 3025).

Acutatheca prolifica new species
Athabascia? sp. 1
Calvinaria bransoni Stainbrook
Cariniferella alleni new species
Coeloterorhynchus magnificum new species

Costatrypa extensa new species

C. varicostata (Stainbrook)

Hypothyridina emmonsii rotunda new subspecies

Nervostrophia mucrospina new species

Spinatrypa trulla decorticata new subspecies

Schizophoria lata Stainbrook

Tylothyrus sulcocostata new species

509g. Sly Gap Formation

Alamo Peak, east slope, 5 miles S. 60° E. of Alamogordo, 0.5 mile west of Holmes Mine, center, E $\frac{1}{2}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 25, T. 16 S., R. 10 E., Otero County, Lincoln Forest Service Map, New Mexico. Collector: A. L. Bowsher.

Acutatheca prolifica new species

Coeloterorhynchus magnificum new species

Costatrypa varicostata (Stainbrook)

Cyrtina inulta Stainbrook

Douvillina parviuscula new species

Hyborhynchella bransoni Cooper

Hypothyridina emmonsii rotunda new subspecies

Indospirifer exfoliata new species

Nervostrophia multinervosa Stainbrook

N. solida new species

Pseudoatrypa devoniana (Webster)

Pseudodouvillina euglyphea Stainbrook

Schizophoria iowensis (Hall)

Spinatrypa compacta new species

Strophonelloides parvulus new species

Thomasaria warreni new species

509h. Sly Gap Formation

Hypothyridina beds to base of sill, 0.63 mile N. 75° E of the mouth of Mule Canyon, Sacramento Mountains, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 9, T. 17 S., R. 10 E., Alamogordo (15') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper.

Acutatheca prolifica new species

Calvinaria bransoni Stainbrook

Cariniferella alleni new species

Coeloterorhynchus magnificum new species

Cyrtina inulta Stainbrook

Douvillina parviuscula new species

Douvillina diversa new species

D. variabilis (Calvin)

Floweria magnificatrix new species

Hyborhynchella bransoni Cooper

Hypothyridina emmonsii rotunda new subspecies

Nervostrophia geniculata new species

N. mucrospina new species

N. solida new species

Productella rugatula Stainbrook

Pseudoatrypa devoniana (Webster)

Spinatrypa trulla decorticata new subspecies

Thomasaria warreni new species

509ha. Sly Gap Formation

Just below the black shale, locality same as 509h.

Coeloterorhynchus magnificum new species

Douvillina rectangulata new species

509i. Sly Gap Formation

2 $\frac{1}{2}$ miles up Alamo Canyon from mouth, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 2, and SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1, T. 17 S., R. 10 E., Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico.

Acutatheca prolifica new species

Cariniferella alleni new species

Coeloterorhynchus magnificum new species

Costatrypa varicostata (Stainbrook)

Cyrtina inulta Stainbrook

509i. (continued)

Douvillinaria variabilis (Calvin)
Floweria prava (Hall)
Hypothyridina emmonsii rotunda new subspecies
Indospirifer exfoliata new species
Nervostrophia geniculata new species
N. mucrospina new species
N. solida new species
Pseudoatrypa devoniana (Webster)
Pseudodouvillina euglyphea Stainbrook
Schizophoria amanaensis Stainbrook
Spinatrypa trulla decorticata new subspecies
Strophonelloides parvulus new species
Thomasaria warreni new species
Tylothyrus sulcocostata new species

509j. Sly Gap Formation

Marble Canyon, east-southeast of Alamogordo, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson (=loc. 506i).

Acutatheca prolifica new species
Aulacella elliptica new species
Calvinaria bransoni Stainbrook
Coeloterorhynchus magnificum new species
Cyrtina inulta Stainbrook
Douvillina parviuscula new species
D. species 1
Gypidula bowsheri new species
Hyborhynchella bransoni Cooper
Nervostrophia solida new species
Productella rugatula Stainbrook
Pseudodouvillina euglyphea Stainbrook
Spinatrypa trulla decorticata new subspecies
Strophodonta umbonata new species
Strophonelloides parvulus new species

509k. Sly Gap Formation

East side of Alamo Peak, N $\frac{1}{2}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 25, T. 16 S., R. 10 E., Alamogordo (15') quadrangle, New Mexico. Collectors: A. L. Bowsher and G. A. Cooper.

Acutatheca prolifica new species
Douvillinaria diversa new species
Indospirifer exfoliata new species
Nervostrophia solida new species
Pseudodouvillina euglyphea Stainbrook
Thomasaria warreni new species

509l. Sly Gap Formation

North side of Caballero Canyon, a branch of Alamo Canyon, southeast of Alamogordo, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Acutatheca prolifica new species
Cyrtina inulta Stainbrook
Nervostrophia solida new species
Productella rugatula Stainbrook
Strophonelloides parvulus new species
Thomasaria warreni new species

509m. Sly Gap Formation (9 feet, 3 inches below the 4-foot black shale)

Arcente Canyon, NW $\frac{1}{4}$ sec. 20, T. 16 S., R. 11 E., Lincoln Forest Service Map, about 7 miles east of Alamogordo, New Mexico. Collectors: A. L. Bowsher and G. A. Cooper.

Acutatheca prolifica new species
Coeloterorhynchus magnificum new species
Hypothyridina emmonsii rotunda new subspecies
Indospirifer exfoliata new species
Pseudodouvillina euglyphea Stainbrook
Sulcatostrophia calvini (Miller)
Thomasaria warreni new species

509n. Sly Gap Formation

NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 22, T. 16 S., R. 10 E., 3 miles east of Alamogordo, Alamogordo (15') quadrangle, New Mexico. Collector: C. C. Branson.

Acutatheca prolifica new species
Aulacella elliptica new species
Calvinaria bransoni Stainbrook
Cariniferella alleni new species
Coeloterorhynchus magnificum new species
Cyrtina inulta Stainbrook
Devonoproductus intermedius new species
Douvillina parviuscula new species
D. rectangulata new species
D. species 1
Floweria prava (Hall)
Gypidula bowsheri new species
Hypothyridina emmonsii rotunda new subspecies
Nervostrophia mucrospina new species
Productella rugatula Stainbrook
Pseudoatrypa devoniana (Webster)
Pseudodouvillina euglyphea Stainbrook
Schizophoria amanaensis Stainbrook
S. iowensis (Hall)
Spinatrypa trulla decorticata new subspecies
Strophodonta umbonata new species
Strophonelloides dorsoconvexus new species
S. parvulus new species
Thomasaria demissa new species
T. warreni new species

509o. Sly Gap Formation

Sheep Mountain, north side of Sly Canyon, sec. 25, T. 11 S., R. 5 E., San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Ambocoelia species 2
Coeloterorhynchus magnificum new species
Cranaena calvini (Hall and Whitfield)
Cyrtina inulta Stainbrook
Strophonelloides dorsoconvexus new species
Thomasaria demissa new species
T. warreni new species

509p. Sly Gap Formation (beds b-g)

One quarter mile north of Rhodes Canyon, SW $\frac{1}{4}$ sec. 3, T. 13 S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico (=loc. 3054).

Aulacella elliptica new species
Cariniferella alleni new species
Coeloterorhynchus magnificum new species
Costatrypa extensa new species
C. varicostata (Stainbrook)
Cyrtina inulta Stainbrook
Nervostrophia mucrospina new species
Schizophoria amanaensis Stainbrook
S. species 2
Spinatrypa trulla decorticata new subspecies
Strophodonta umbonata new species
Strophonelloides dorsoconvexus new species
Thomasaria demissa new species
Tylothyrus sulcocostata new species

509q. Sly Gap Formation (lower half)

Sec. 25, T. 11 S., R. 5 E., Sheep Mountain, north side of Sly Canyon, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico (=loc. 3016). Collectors: W. T. Allen and A. L. Bowsher.

Aulacella elliptica new species
Calvinaria bransoni Stainbrook

509q. (continued)

- Coeloterorhynchus magnificum* new species
Devonoproductus intermedius new species
Gypidula bowsheri new species
Nervostrophia geniculata new species
Spinatrypa trulla decorticata new subspecies
Tenticospirifer cf. *T. cyrtinaformis* (Hall and Whitfield)
Thomasaria demissa new species
T. warreni new species

509r. Sly Gap Formation

Same as locality 509p. Collectors: W. T. Allen and A. L. Bowsher.

- Aulacella elliptica* new species
Cariniferella alleni new species
Devonoproductus intermedius new species
Douvillina parviuscula new species
Eostrophalosia inexpectata new subspecies
Iowatrypa rara new species
Nervostrophia mucrospina new species
N. solida new species
Pseudoatrypa devoniana (Webster)
Schizophoria amanaensis Stainbrook
Spinatrypa trulla decorticata new subspecies
Strophonelloides dorsoconvexus new species
S. parvulus new species
Thomasaria demissa new species
T. warreni new species
Tylothyris sulcocoata new species

509s. Sly Gap Formation

South slope of Sheep Mountain, opposite windmill in Sly Canyon, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collectors: C. C. Branson, E. L. Yochelson, and G. A. Cooper.

- Aulacella elliptica* new species
Calvinaria bransoni Stainbrook
Coeloterorhynchus magnificum new species
Cyrtina inulta Stainbrook
Cyrtospirifer whitneyi (Hall)
Devonoproductus intermedius new species
Douvillina parviuscula new species
D. species 1
Elita magister new species
Floweria prava (Hall)
Gypidula bowsheri new species
Hypothyridina emmonsii rotunda new subspecies
Indospirifer anomala new species
Nervostrophia mucrospina new species
N. solida new species
Productella rugatula Stainbrook
Pseudoatrypa devoniana (Webster)
Rhipidomella species 1
Schizophoria iowensis (Hall)
Spinatrypa trulla decorticata new subspecies
Strophodonta umbonata new species
Strophonelloides parvulus new species
Thomasaria warreni new species
Tylothyris sulcocoata new species

509t. Contadero Formation (zones k-m)

One quarter mile north of Rhodes Canyon, SW¼ sec. 3, T. 13 S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico. Collectors: A. L. Bowsher and G. A. Cooper (=loc. 3054k).
Ambocoelia species 2
Crinisarina reticulata (Stainbrook)
Cupularostrum? stvensoni new species

- Cyrtospirifer pyramidalis* new species
C. whitneyi (Hall)
Douvillina contaderoensis new species
Productella species 1
Ripidiorhynchus newmexicoense new species
Spinatrypa obsolescens new species
Tylothyris species 1

509u. Rhodes Canyon Formation (beds o-r)

Same locality as 509t.

- Afilasma inexpectatum* new species
Aulacella elliptica new species
Crinisarina reticulata (Stainbrook)
Cupularostrum? stvensoni new species
Cyrtospirifer pyramidalis new species
Productella species 1
P. species 2
Ripidiorhynchus newmexicoense new species
Tylothyris novamexicana Stainbrook

509v. Sly Gap Formation

Upper 10 feet, Alamo Peak, sec. 25, T. 16 S., R. 10 E. Lincoln Forest Service Map, east of Alamogordo, New Mexico.

- Acutathea prolifica* new species
Calvinaria bransoni Stainbrook
Coeloterorhynchus magnificum new species
Costatrypa varicostata (Stainbrook)
Cyrtina inulta Stainbrook
Devonoproductus vulgaris Stainbrook
Floweria prava (Hall)
Gypidula bowsheri new species
Spinatrypa trulla decorticata new subspecies
Thomasaria warreni new species

509w. Sly Gap Formation (0-10 feet below the 4-foot black shale) W½SW¼ sec. 7, T. 16 S., R. 11 E., first canyon north of Pig Canyon, 6 miles east-northeast of Alamogordo, Sacramento Mountains, Lincoln Forest Service Map, New Mexico.

- Acutathea prolifica* new species
Coeloterorhynchus magnificum new species
Cranaena calvini (Hall and Whitfield)
Devonoproductus vulgaris Stainbrook
Hyborhynchella bransoni Cooper
Hypothyridina emmonsii rotunda new subspecies
Indospirifer exfoliata new species
Pseudodouvillina euglyphea Stainbrook
Spinatrypa trulla decorticata new subspecies
Sulcatostrophia calvini (Miller)
Thomasaria warreni new species

509x. Sly Gap Formation (above the 4-foot black shale)

Same as locality 509w.

- Aulacella elliptica* new species
Cyrtina inulta Stainbrook
Douvillina parviuscula new species
D. species 1
Floweria prava (Hall)
Schizophoria amanaensis Stainbrook
Spinatrypa trulla decorticata new subspecies
Thomasaria warreni new species
Tylothyris sulcocoata new species

509y. Sly Gap Formation (above 3-foot bed of black shale)

Alamo Canyon, 2.5 miles up from mouth, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico.

- Aulacella elliptica* new species
Cyrtina inulta Stainbrook
Douvillina parviuscula new species
Pseudoatrypa devoniana (Webster)

509y. (continued)

- Schizophoria iowensis* (Hall)
Spinatrypa trulla decorticata new subspecies
Sulcatostrophia calvini (Miller)

509z. Sly Gap Formation

Collection made by students of Dr. C. L. Baker in Lava Gap, Sheep Mountain, Capitol Peak (15') quadrangle, New Mexico.

- Calvinaria bransoni* Stainbrook
Costatrypa varicostata (Stainbrook)
Cranaena calvini (Hall and Whitfield)
Cyrtospirifer whitneyi (Hall)
Devonoproductus intermedius new species
Floweria prava (Hall)
Hypothyridina emmonsii rotunda new subspecies
Indospirifer anomala new species
Nervostrophia mucrospina new species
Pseudoatrypa devoniana (Webster)
Schizophoria amanaensis Stainbrook
Spinatrypa trulla decorticata new subspecies
Strophonelloides parvulus new species
Tylothyris sulcocostata new species

521c. Sly Gap Formation (below the sill)

SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 9, T. 17 S., R. 10 E., 0.75 mile N. 60° E. of the mouth of Mule Canyon, Sacramento Mountains, Alamo-gordo (15') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper.

- Aulacella elliptica* new species
Calvinaria bransoni Stainbrook
Cariniferella alleni new species
Coeloterorhynchus magnificum new species
Cyrtina inulta Stainbrook
Douvillina diversa new species
Floweria prava (Hall)
Hyborhynchella bransoni Cooper
Hypothyridina emmonsii rotunda new subspecies
Nervostrophia solida new species
Petrocrania specifically unidentified
Productella rugatula Stainbrook
Pseudoatrypa devoniana (Webster)
Schizophoria iowensis (Hall)
Spinatrypa trulla decorticata new subspecies
Sulcatostrophia calvini (Miller)
Thomasaria warreni new species

521d. Sly Gap Formation

Type section Sly Gap Formation, sec. 25, T. 11 S., R. 5 E., San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico.

Collectors: F. V. Stevenson and A. L. Bowsher.

- Aulacella elliptica* new species
Calvinaria bransoni Stainbrook
Costatrypa extensa new species
C. varicostata (Stainbrook)
Cyrtina inulta Stainbrook
Cyrtospirifer cf. *C. thalattodoxa* Crickmay
C. whitneyi (Hall)
C. species 3
Devonoproductus intermedius new species
Douvillina parviuscula new species
D. species 1
Elita magister new species
Hyborhynchella bransoni Cooper
Hypothyridina emmonsii rotunda new subspecies
Indospirifer anomala new species
I. exfoliata new species

Iowatrypa rara new species*Nervostrophia geniculata* new species*N. mucrospina* new species*N. multinervosa* Stainbrook*N. solida* new species*Productella rugatula* Stainbrook*Pseudoatrypa devoniana* (Webster)*Schizophoria amanaensis* Stainbrook*S. iowensis* (Hall)*Spinatrypa trulla decorticata* new subspecies*Strophodonta umbonata* new species*Strophonelloides dorsoconvexus* new species*S. parvulus* new species*Sulcatostrophia calvini* (Miller)*Tenticospirifer* cf. *T. cyrtinaformis* (Hall and Whitfield)*Thomasaria warreni* new species*Tylothyris sulcocostata* new species

521e. Sly Gap Formation

One quarter mile north of Rhodes Canyon, SW $\frac{1}{4}$ sec. 3, T. 13 S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico.

Collector: F. V. Stevenson.

- Aulacella elliptica* new species
Calvinaria bransoni Stainbrook
Cariniferella alleni new species
C. species
Coeloterorhynchus magnificum new species
Costatrypa extensa new species
C. varicostata (Stainbrook)
Cyrtina inulta Stainbrook
Devonoproductus intermedius new species
Douvillina parviuscula new species
D. rectangulata new species
Douvillina variabilis (Calvin)
Floweria prava (Hall)
Gypidula bowsheri new species
Hypothyridina emmonsii rotunda new subspecies
Nervostrophia mucrospina new species
N. solida new species
Productella rugatula Stainbrook
Pseudoatrypa devoniana (Webster)
Schizophoria amanaensis Stainbrook
Spinatrypa trulla decorticata new subspecies
Strophodonta umbonata new species
Strophonelloides parvulus new species
Thomasaria demissa new species
T. warreni new species
Tylothyris sulcocostata new species

521f. Contadero Formation (Bed F, near top)

Rhodes Canyon, San Andres Mountains, Black Top Mountain (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

- Crinisarina reticulata* (Stainbrook)
Cyrtospirifer pyramidalis new species
Schizophoria species indeterminate
Tylothyris species 1

521g. Rhodes Canyon Formation (Zone E)

Same as locality 521e. Collector: F. V. Stevenson.

- Crinisarina reticulata* (Stainbrook)
Cupularostrum? *stevensoni* new species
Cyrtospirifer whitneyi (Hall)
Tylothyris novamexicana Stainbrook

521h. Rhodes Canyon Formation (Zone D)

Same as locality 521e. Collector: F. V. Stevenson.

- Crinisarina reticulata* (Stainbrook)

521h. (continued)

Cyrtospirifer pyramidalis new species
C. cf. C. thalattodoxa Crickmay
Productella species 1

521i. Rhodes Canyon Formation (Zone C)

Same as locality 521e. Collector: F. V. Stevenson.
Crinisarina reticulata (Stainbrook)

521j. Contadero Formation (Zone G)

Same as locality 521e. Collector: F. V. Stevenson.
Ambocoelia species 2
Cupularostrum? stevensoni new species
Douvillina contaderoensis new species
Ripidiorhynchus newmexicoense new species
Spinatrypa obsolescens new species
Tylothyris species 1

521k. Sly Gap Formation (lower)

Sheep Mountain, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25, T. 11 S., R. 5 E., Capitol Peak (15') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper (=loc. 521m).

Aulacella elliptica new species
Calvinaria bransoni Stainbrook
Cariniferella alleni new species
Coeloterorhynchus magnificum new species
Costatrypa extensa new species
C. varicostata (Stainbrook)
Cyrtina inulta Stainbrook
Devonoproductus intermedius new species
Gypidula subcarinata new species
Hypothyridina emmonsii rotunda new subspecies
Indospirifer aff. *I. orestes* (Hall and Whitfield)
Iowatrypa rara new species
Nervostrophia mucrospina new species
Productella rugatula Stainbrook
Pseudoatrypa devoniana (Webster)
Schizophoria iowensis (Hall)
Spinatrypa trulla decorticata new subspecies
Thomasaria demissa new species
T. warreni new species
Tylothyris sulcocostata new species

521l. Sly Gap Formation

Pig Canyon anticline, 2 miles N. 7° E. of Ortega Peak, 4.5 miles N. 80° E. of Alamogordo, SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 16 S., R. 11 E., Lincoln Forest Service Map, New Mexico. Collectors: W. T. Allen and A. L. Bowsher.

Acutatheca prolifica new species
Coeloterorhynchus magnificum new species
Costatrypa varicostata (Stainbrook)
Cyrtina inulta Stainbrook
Indospirifer exfoliata new species
Nervostrophia solida new species
Pseudodouvillina euglyphea Stainbrook
Spinatrypa trulla decorticata new subspecies
Sulcatostrophia calvini (Miller)
Thomasaria warreni new species

521m. Sly Gap Formation (lower 20 feet)

Center NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25, T. 11 S., R. 5 E., Sheep Mountain, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper (=loc. 521k).

Aulacella elliptica new species
Calvinaria bransoni Stainbrook
Coeloterorhynchus magnificum new species
Costatrypa extensa new species
C. varicostata (Stainbrook)
Devonoproductus intermedius new species

Douvillina parviuscula new species

D. sp. 1

Douvillinaria diversa new species

D. variabilis (Calvin)

Elita magister new species

Floweria prava (Hall)

Hypothyridina emmonsii rotunda new subspecies

Nervostrophia mucrospina new species

Petrocrania specifically unidentified

Productella rugatula Stainbrook

Pseudoatrypa devoniana (Webster)

Schizophoria iowensis (Hall)

Spinatrypa trulla decorticata new subspecies

Thomasaria warreni new species

Tylothyris sulcocostata new species

521n. Sly Gap Formation

Arcente Canyon, 7 miles south of High Rolls, SE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 20, T. 16 S., R. 11 E., Lincoln Forest Service Map, Sacramento Mountains, New Mexico. Collectors: A. L. Bowsher and W. T. Allen.

Douvillina minuta new species

Hypothyridina emmonsii rotunda new subspecies

Indospirifer exfoliata new species

Nervostrophia solida new species

Thomasaria warreni new species

521o. Sly Gap Formation

Deadman Canyon, 3 miles southwest of Alamogordo, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico (=loc. 526f).

Acutatheca prolifica new species

Cariniferella alleni new species

Coeloterorhynchus magnificum new species

Cranaena calvini (Hall and Whitfield)

Cyrtina inulta Stainbrook

Nervostrophia solida new species

Pseudodouvillina euglyphea Stainbrook

Spinatrypa trulla decorticata new subspecies

Thomasaria warreni new species

521p. Sly Gap Formation

Alamo Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson (=loc. 526n).

Acutatheca prolifica new species

Cariniferella alleni new species

Coeloterorhynchus magnificum new species

Devonoproductus intermedius new species

Hypothyridina emmonsii rotunda new subspecies

Nervostrophia geniculata new species

N. extensa new species

Productella rugatula Stainbrook

521q. Sly Gap Formation (upper 25 feet)

Center NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25, T. 11 S., R. 5 E., Sheep Mountain, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper.

Aulacella elliptica new species

Costatrypa varicostata (Stainbrook)

Cyrtina inulta Stainbrook

Devonoproductus intermedius new species

Douvillina parviuscula new species

Elita magister new species

Indospirifer anomala new species

Iowatrypa rara new species

Nervostrophia geniculata new species

N. mucrospina new species

Petrocrania specifically unidentified

521q. (continued)

Pseudoatrypa devoniana (Webster)*Schizophoria iowensis* (Hall)*Thomasaria warreni* new species

521r. Sly Gap Formation

Sheep Mountain, San Andres Range, sec. 25, T. 11 S., R. 5 E., Capitol Peak (15') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro (=loc. 521d).

Acutatheca prolifica new species*Calvinaria bransoni* Stainbrook*Coeloterorhynchus magnificum* new species*Cranaena calvini* (Hall and Whitfield)*Cyrtina inulta* Stainbrook*Devonoproductus intermedius* new species*Douvillina parviuscula* new species*Hypothyridina emmonsii rotunda* new subspecies*Indospirifer exfoliata* new species*Productella rugatula* Stainbrook*Pseudodouvillina euglyphea* Stainbrook*Spinatrypa trulla decorticata* new subspecies*Thomasaria warreni* new species

521s. Sly Gap Formation (lower)

Center NW¼SE¼ sec. 12, T. 17 S., R. 3 E., Deadman Canyon, San Andres Range, Kaylor Mountain (15') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Aulacella elliptica new species*Calvinaria bransoni* Stainbrook*Cariniferella iowensis* Stainbrook*Douvillina diversa* new species*Nervostrophia mucrospina* new species*N. solida* new species*Productella rugatula* Stainbrook*Pseudoatrypa devoniana* (Webster)*Schizophoria iowensis* (Hall)

521t. Sly Gap Formation (bed just above Oñate Formation)

Sheep Mountain, NW¼SW¼ sec. 25, T. 11 S., R. 5 E., Capitol Peak Quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Aulacella elliptica new species*Costatrypa varicostata* (Stainbrook)*Cyrtina inulata* Stainbrook*Douvillina diversa* new species*Nervostrophia mucrospina* new species*Pseudoatrypa devoniana* (Webster)*Spinatrypa trulla decorticata* new subspecies*Strophodonta umbonata* new species

521u. Sly Gap Formation (top 23 feet)

Capitol Peak, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collectors: A. L. Bowsher and J. T. Dutro.

Cariniferella alleni new species*Costatrypa extensa* new species*C. varicostata* (Stainbrook)*Cyrtospirifer whitneyi* (Hall)*Devonoproductus intermedius* new species*Hypothyridina emmonsii rotunda* new subspecies*Indospirifer* aff. *I. orestes* (Hall and Whitfield)*Nervostrophia mucrospina* new species*N. solida* new species*Pseudoatrypa devoniana* (Webster)*Strophonelloides parvulus* new species521v. Sly Gap Formation (Bed K—*Thomasaria* Bed)

Mud Springs Mountains, NE¼SE¼ sec. 24, T. 13 S., R. 5 W., west of Truth-or-Consequences, Cuchillo (7½') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Calvinaria bransoni Stainbrook*Costatrypa varicostata* (Stainbrook)*Douvillina diversa* new species*Nervostrophia solida* new species*Productella rugulata* Stainbrook*Thomasaria demissa* new species

521w. Sly Gap Formation (Number 2 of A. L. Bowsher)

Capitol Peak, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collectors: A. L. Bowsher and J. T. Dutro.

Costatrypa extensa new species*C. varicostata* (Stainbrook)*Devonoproductus intermedius* new species*Nervostrophia geniculata* new species*N. mucrospina* new species*Productella rugulata* Stainbrook*Pseudoatrypa devoniana* (Webster)*Schizophoria iowensis* (Hall)

521x. Sly Gap Formation (Number 3 of A. L. Bowsher)

Same as locality 521u.

Costatrypa varicostata (Stainbrook)*Nervostrophia solida* new species

521y. Sly Gap Formation (Number 4 of Bowsher)

Same as locality 521u.

522. Thoroughgood Formation (basal bed)

Sheep Mountain, SE¼NE¼ sec. 26, T. 11 S., R. 5 E., Capitol Peak (15') quadrangle, New Mexico. Collectors: J. T. Dutro, G. A. Cooper and F. V. Stevenson.

Afilasma species*Ambocoelia* species 3*Athabascia?* species 2*Camarotoechia latisinuata* new species*Colophragma* species 2*Crinisarina reticulata* (Stainbrook)*Cyrtospirifer arenarius* new species*C. species 1**C. species 2**Evanesicrostrum* species 1*Productella* species 3*Tylothyrus compacta* new species

522a. Contadero Formation (Zone 4)

Amphitheater, north of Rhodes Canyon, center N½SW¼NE¼ sec. 9, T. 13 S., R. 4 E., San Andres Mountains, Black Top Mountain (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Douvillina contaderoensis new species*Ripidiorhynchus newmexicoense* new species*Spinatrypa compacta* new species*S. obsolescens* new species*Tylothyrus compacta* new species

522b. Sly Gap Formation

Same as locality 522a. Collector: F. V. Stevenson.

Thomasaria demissa new species*T. warreni* new species

522c. Oñate Formation (Bed F)

Rhodes Canyon, San Andres Mountains, New Mexico. Collector: A. L. Bowsher

Schizophoria lata Stainbrook

522d. Oñate Formation (Zone I)

East side of Alamo Peak, ½ mile west of Holmes Mine, center E½NW¼NE¼SE¼ sec. 25, T. 16 S., R. 10 E., Lincoln Forest Service Map, east of Alamogordo, New Mexico. Collector: A. L. Bowsher.

Nervostrophia plana new species*Platyterorhynchus obscurum* new species*Striatochonetes nanus* new species

- 522e. Oñate Formation (Collection C)
East side of Alamo Peak (same as locs. 522d, 3053).
Platyerorhynchus obscurum new species
Striatochonetes nanus new species
- 522f. Oñate Formation (*Sphaerospongia* Bed = Bed E of Cooper and Dutro)
NE¼SE¼ sec. 24, T. 13 S., R. 5 W., Mud Springs Mountains, Cuchillo (7½') quadrangle, New Mexico. Collector: C. C. Branson.
Atryparia rubra new species
Cranaena species 1
Desquamatia costata new species
Leiorhynchus sphaericum new species
Morphorhynchus varicostatum new species
Mucrospirifer parvus new species
Schizophoria lata Stainbrook
- 522g. Same as locality 522f.
- 522h. Oñate Formation (Bed F)
Same as locality 506y. Collectors: G. A. Cooper and J. T. Dutro.
Nervostrophia plana new species
Schizophoria lata Stainbrook
- 522i. Oñate Formation (Beds B and C)
Same as locality 522d. Collector: A. L. Bowsher.
Echinocoelia pretiosa new species
Mucrospirifer parvus new species
Platyerorhynchus obscurum new species
Striatochonetes nanus new species
- 522j. Oñate Formation (40–50 feet above the base)
Same as locality 506y. Collector: A. L. Bowsher.
Dichacaenia umbonata new species
Petrocrania specifically unidentified
Platyerorhynchus obscurum new species
Rhysochonetes johnsoni new species
Schizophoria lata Stainbrook
- 522k. Sly Gap Formation (43–83 feet above base)
Same as locality 506y. Collectors: W. T. Allen, A. L. Bowsher and G. A. Cooper.
Coeloterorhynchus species
Costatrypa varicostata (Stainbrook)
Cyrtina inulta Stainbrook
Devonoproductus intermedius new species
Nervostrophia solida new species
Productella rugatula Stainbrook
Thomasaria demissa new species
- 522l. Oñate Formation (basal 19 feet of section)
Same as locality 506y. Collectors: A. L. Bowsher, W. T. Allen and G. A. Cooper.
Atryparia rubra new species
Desquamatia costata new species
Leiorhynchus sphaericum new species
Morphorhynchus varicostatum new species
(For conodonts see USGS 9312-SD)
- 522m. Oñate Formation
Rhodes Pass, SW¼ sec. 3, T. 13 S., R. 4 E., San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico.
Ambocoelia species 4
Cyrtina variabilis new species
Leiorhynchus sphaericum new species
Mucrospirifer parvus new species
Platyerorhynchus obscurum new species
- 522n. Oñate Formation (Bed B)
Same as locality 506y.
Echinocoelia pretiosa new species
Emanuella species
- Hypothyridina* species
Nervostrophia plana new species
Rhysochonetes johnsoni new species
- 522o. Oñate Formation
Same as locality 506y. Collector: F. V. Stevenson.
Cyrtina variabilis new species
Desquamatia costata new species
- 522q. Oñate Formation (*Ambocoelia* beds)
Base of section, north end of Derry Hills, northeast of Derry, Garfield (7½') quadrangle, New Mexico.
Ambocoelia species 4
- 522s. Sly Gap Formation?
Base of blocky sandstone at top of section; sec. 1, T. 18 S., R. 3 W., northwest of Rincon, Rincon (7½') quadrangle, New Mexico.
Collectors: G. A. Cooper and J. T. Dutro.
Cyrtospirifer species 5
Eleutherokomma species
- 522t. Oñate Formation
NE¼SE¼, sec. 22, T. 17 S., R. 4 W., Caballo Mountains, Upham (15') quadrangle, New Mexico. Collector: F. V. Stevenson.
Atryparia rubra new species
- 522u. Oñate Formation
Same as locality 506y.
- 522v. Same as locality 522l.
- 522w. Same as locality 521v.
- 522x. Sly Gap Formation (Bed J)
Same as locality 506y.
Costatrypa varicostata (Stainbrook)
Tylothyrus sulcocostata new species
- 522y. Sly Gap Formation (Bed I)
Same as locality 506y.
Cyrtina inulta Stainbrook
- 522z. Oñate Formation
Same as locality 506y.
Nervostrophia plana new species
Rhysochonetes johnsoni new species
523. Oñate Formation
Same as locality 506y. Collector: F. V. Stevenson.
Strophodonta species 1
Warrenella floweri new species
- 523a. Oñate Formation
Sec. 1, T. 18 S., R. 3 W., northwest of Rincon, New Mexico.
Atryparia rubra new species
Hadrorthynchia alta new species
Nervostrophia plana new species
Schizophoria lata Stainbrook
Strophodonta species 1
Warrenella magna new species
- 523b. Oñate Formation (beds with *Warrenella* and *Hadrorthynchia*)
North end of Derry Hills, northeast of Derry, Garfield (7½') quadrangle, New Mexico (=loc. 523f). Locality now under roadbed of Interstate Highway 25.
Desquamatia costata new species
Dichacaenia umbonata new species
Echinocoelia pretiosa new species
Hadrorthynchia alta new species
H. mclareni new species
Nervostrophia plana new species
Striatochonetes nanus new species
Warrenella magna new species
- 523c. Sly Gap Formation (Bed G)
Cobbly zone, same as locality 506y.
Calvinaria bransonii Stainbrook

523c. (continued)

Nervostrophia solida new species
Thomasaria warreni new species

523d. Oñate Formation

Nackaye Mine, center SW¼ sec. 15 and NW¼ sec. 22, T. 17 S., R. 4 W., Caballos Mountains, Upham (15') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Cupularostrum? species
Cyrtina variabilis new species
Desquamatia costata new species
Hadorrhynchia alta new species
H. mclareni new species
Hypothyridina species
Leiorhynchus sphaericum new species
Nervostrophia plana new species
Petrocrania species 1
Schizophoria lata Stainbrook
Warrenella magna new species

523e. Oñate Formation (lower brown beds = c-d)

East of measured section at locality 506y.

Ambocoelia species 4
Desquamatia costata new species
Dichacaenia perplexa new species
Hadorrhynchia alta new species
Leiorhynchus sphaericum new species
Morphorhynchus varicostatum new species
Mucrospirifer parvus new species
Nervostrophia plana new species
Schizophoria lata Stainbrook
Strophodonta species 1
Warrenella floweri new species

523f. Oñate Formation

Derry Hills, center, east boundary, SW¼ sec. 29, T. 17 S., R. 4 W., just northwest of Derry warm spring, Caballo Mountains, Garfield (7½') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper (= loc. 523b). [Now under Interstate Highway 25.]

Cyrtina variabilis new species
Desquamatia costata new species
Echinocoelia pretiosa new species
Hadorrhynchia alta new species
H. mclareni new species
Schizophoria lata Stainbrook
Striatochonetes nanus new species
S. subcarinatus new species
Warrenella magna new species

523g. Oñate Formation (Bed B)

Red House Mountain, NW¼NW¼ sec. 14, T. 18 S., R. 3 W., north-northeast of Hatch, Rincon (7½') quadrangle, New Mexico.

Desquamatia costata new species
Warrenella magna new species

523h. Oñate Formation (Bed B)

Red House Mountain, SW¼SW¼SW¼ sec. 11, T. 18 S., R. 3 W., just east of barite mine, Caballo Mountains, Upham (15') quadrangle, New Mexico.

Hadorrhynchia alta new species
H. mclareni new species
Schizophoria lata Stainbrook
Warrenella magna new species

523i. Oñate Formation (beds C-D)

Sphaerospongia beds, same as locality 522f.

Cyrtina variabilis new species
Desquamatia costata new species

Dichacaenia umbonata new species
Hadorrhynchia alta new species
Morphorhynchus varicostatus new species
Mucrospirifer parvus new species
Nervostrophia plana new species
Schizophoria lata Stainbrook
Warrenella floweri new species

523j. Oñate Formation

Old mine shaft, NW¼NW¼ sec. 22, T. 17 S., R. 4 W., Caballo Mountains, Upham (15') quadrangle, New Mexico (=loc. 523d).

Desquamatia costata new species
Dichacaenia perplexa new species
Warrenella magna new species

523k. Oñate Formation (lower Warrenella)

SW¼NE½ sec. 22, T. 17 S., R. 4 W., southeast of Nackaye Mines, Caballo Mountains, Upham (15') quadrangle, New Mexico.

Desquamatia costata new species
Hadorrhynchia mclareni new species
Schizophoria lata Stainbrook
Warrenella magna new species
W. floweri new species

523l. Contadero Formation

Rhodes Pass, same as localities 506w and 526g.

523m. Sly Gap Formation (Bed J of Cooper, field designation)

Rhodes Pass, same as locality 509p.
Costatrypa varicostata (Stainbrook)
Elita magister new species
Pseudoatrypa devoniana (Webster)
Schizophoria amanaensis Stainbrook
Spinatrypa trulla decorticata new subspecies
Strophonelloides parvulus new species
Tylothyris sulcocostata new species

523n. Contadero Formation (topmost)

Sheep Mountain, SE¼NE¼ sec. 26, T. 11 S., R. 5 E., Capitol Peak (15') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Crinisarina reticulata (Stainbrook)
Cyrtospirifer whitneyi (Hall)
Douvillina contaderoensis new species
Floweria aff. *F. chemungensis* (Conrad)
Productella? species 2
Schizophoria species indeterminate
Spinatrypa compacta new species
Tylothyris species 1

523o. Oñate Formation (upper Warrenella bed)

Paint Mine, NW¼NE¼ sec. 27, T. 17 S., R. 4 W., one mile southeast of Nackaye Mine, Caballo Mountains, Upham (15') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Atryparia rubra new species
Cyrtina variabilis new species
Desquamatia costata new species
Dichacaenia perplexa new species
Warrenella magna new species
W. floweri new species

523oa. (loose at loc. 523o.)

Aulacella elliptica new species

523p. Rhodes Canyon Formation

Ash Canyon, center NE¼ sec. 20, T. 14 S., R. 4 E., San Andres Mountains, Black Top Mountain (15') quadrangle, New Mexico.

Cupularostrum? *stevensoni* new species
Cyrtospirifer pyramidalis new species
Tylothyris species 1

523q. Contadero Formation

Same as locality 523p.

Colophragma ellipticum new species*Crinisarina reticulata* (Stainbrook)*Cupularostrum? stvensoni* new species*Cyrtospirifer whitneyi* (Hall)*Tylothyrus novamexicana* Stainbrook*Uchtospirifer? rarus* new species

523r. Contadero Formation

San Andres Canyon, San Andres Mountains, Bear Peak (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

Douvillina species 2

523s. Oñate Formation

Type section of the formation, north side San Andres Canyon, sec. 18, T. 18 S., R. 4 E., Bear Peak (15') quadrangle, New Mexico. Near old lead mine.

Dichacaenia umbonata new species*Echinocoelia pretiosa* new species*Nervostrophia plana* new species*Platyterorhynchus obscurum* new species*Schizophoria lata* Stainbrook*Striatochonetes nanus* new species*Warrenella magna* new species523t. Oñate Formation (bed with *Warrenella*)

Same as locality 523s.

Cyrtina variabilis new species*Desquamatia costata* new species*Dichacaenia umbonata* new species*Schizophoria lata* Stainbrook*Strophodonta* species 1*Warrenella magna* new species

523u. Oñate Formation

San Andres Canyon, San Andres Range, Bear Peak (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Desquamatia costata new species*Dichacaenia umbonata* new species*Mucrospirifer parvus* new species*Nervostrophia plana* new species*Platyterorhynchus obscurum* new species*Schizophoria lata* Stainbrook

"Schuchertella" species

523v. Rhodes Canyon Formation

Same as locality 506w. Collector: A. L. Bowsher.

Afilasma inexpectatum new species*Crinisarina reticulata* (Stainbrook)*Cupularostrum? stvensoni* new species*Tylothyrus novamexicana* Stainbrook

523w. Oñate Formation (Bed B)

SE¼SE¼ sec. 26, T. 18 S., R. 10 E., 0.25 mile southeast of Escondido Canyon, Sacramento Mountains, Escondido Canyon (15') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Platyterorhynchus obscurum new species*Striatochonetes nanus* new species

523x. Oñate Formation (Bed C)

Same as locality 523w. Collectors: G. A. Cooper and J. T. Dutro.

Desquamatia costata new species*Nervostrophia plana* new species*Platyterorhynchus obscurum* new species*Schizophoria lata* Stainbrook*Striatochonetes nanus* new species

523y. Oñate Formation ("Leiorhynchus" Bed)

NW¼SW¼ sec. 12, T. 17 S., R. 3 E., Deadman Canyon, San

Andres Mountains, Kaylor (15') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Platyterorhynchus obscurum new species*Schizophoria lata* Stainbrook

523z. Oñate Formation (Bed E)

Same as locality 523w.

Desquamatia costata new species*Dichacaenia umbonata* new species*Mucrospirifer parvus* new species*Platyterorhynchus obscurum* new species*Schizophoria lata* Stainbrook

524. Oñate Formation

SE¼NE¼ sec. 2, T. 17 S., R. 10 E., Alamo Canyon, Alamogordo (15') quadrangle, New Mexico.

Platyterorhynchus obscurum new species

524a. Oñate Formation (6 to 8 feet below the top)

Deadman Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico.

Cyrtina variabilis new species*Mucrospirifer parvus* new species*Nervostrophia plana* new species*Platyterorhynchus obscurum* new species*Striatochonetes nanus* new species

524b. Oñate Formation

Dog Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico.

Desquamatia costata new species*Platyterorhynchus obscurum* new species

524c. Contadero Formation

Center NW¼SW¼ sec. 25, T. 11 S., R. 5 E., Sheep Mountain, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico.

Crinisarina reticulata (Stainbrook)*Schizophoria* species indeterminate

524d. Oñate Formation

First small canyon tributary of Dog Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Cyrtina variabilis new species*Desquamatia costata* new species

524e. Rhodes Canyon Formation

Same as localities 506w, 3054q.

Crinisarina reticulata (Stainbrook)*Cyrtospirifer pyramidalis* new species*Productella* species 1

524f. Oñate Formation (25 feet above base)

South wall of Escondido Canyon, center sec. 26, T. 18 S., R. 10 E., Escondido Canyon (15') quadrangle, New Mexico.

Desquamatia costata new species*Dichacaenia umbonata* new species*Mucrospirifer parvus* new species*Platyterorhynchus obscurum* new species*Schizophoria lata* new species

524g. Oñate Formation

Alamo Peak, sec. 25, T. 16 S., R. 10 E., east of Alamogordo, Lincoln Forest Service Map, New Mexico.

Mucrospirifer parvus new species*Platyterorhynchus obscurum* new species*Striatochonetes nanus* new species

524h. Oñate Formation (11.8 to 16.6 feet)

Same as locality 524g.

Platyterorhynchus obscurum new species*Striatochonetes nanus* new species

524i. Oñate Formation (Bed C of Cooper)

Same as locality 524g.

- Ambocoelia* species 4
- Atryparia rubra* new species
- Echinocoelia pretiosa* new species
- Emanuella* species
- Nervostrophia plana* new species

524j. Oñate Formation (Bed F of Cooper)

Same as locality 524g.

- Mucrospirifer parvus* new species
- Platyterorhynchus obscurum* new species
- Schizophoria lata* Stainbrook
- Striatochonetes nanus* new species

524k. Oñate Formation (Bed K of Cooper)

Same as locality 524g.

- Nervostrophia plana* new species
- Platyterorhynchus obscurum* new species

524l. Oñate Formation (Beds G–K of Cooper)

Same as locality 524g.

- Desquamatia costata* new species
- Mucrospirifer parvus* new species
- Nervostrophia plana* new species
- Platyterorhynchus obscurum* new species
- Striatochonetes nanus* new species

524m. Sly Gap Formation

Center NE¼ sec. 20, T. 14 S., R. 4 E., Ash Canyon, San Andres Mountains, Black Top Mountain (15') quadrangle, New Mexico.

- Aulacella elliptica* new species
- Cariniferella alleni* new species
- Coeloterorhynchus magnificum* new species
- Costatrypa extensa* new species
- C. varicostata* (Stainbrook)
- Cranaena calvini* (Hall and Whitfield)
- Cyrtina inulta* Stainbrook
- Devonoproductus intermedius* new species
- Douvillina minuta* new species
- D. parviuscula* new species
- Douvillinaria diversa* new species
- Elita magister* new species
- Floweria prava* (Hall)
- Hyborhynchella bransoni* Cooper
- Hypothyridina emmonsii* rotunda new subspecies
- Indospirifer anomala* new species
- Nervostrophia geniculata* new species
- N. solida* new species
- Productella rugatula* Stainbrook
- Pseudoatrypa devoniana* (Webster)
- Schizophoria iowensis* (Hall)
- Spinatrypa trulla decorticata* new subspecies
- Strophodonta umbonata* new species
- Strophonelloides dorsoconvexus* new species
- Thomasaria warreni* new species
- Tylothyris sulcocostata* new species

524n. Sly Gap Formation

Same as locality 521t. Collectors: G. A. Cooper and J. T. Dutro.

- Costatrypa varicostata* (Stainbrook)
- Cyrtina inulta* Stainbrook
- Devonoproductus intermedius* new species
- Douvillina parviuscula* new species
- Elita magister* new species
- Floweria prava* (Hall)
- Gypidula bowsheri* new species
- Indospirifer exfoliata* new species

Nervostrophia geniculata new species*N. mucrospina* new species*Pseudoatrypa devoniana* (Webster)*Schizophoria amanaensis* Stainbrook*S. iowensis* (Hall)*Spinatrypa trulla decorticata* new subspecies*Strophonelloides parvulus* new species*Thomasaria warreni* new species

524o. Contadero Formation (lower 5 feet)

Center SW¼ sec. 2, T. 16 S., R. 4 E., Hembrillo Canyon, San Andres Mountains, Kaylor Mountain (15') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.

Ambocoelia species 2*Aulacella elliptica* new species*Barroisella* species*Colophragma ellipticum* new species*C. species* 1*Crinisarina reticulata* (Stainbrook)*Evanesicrostrum glabraventrum* (Stainbrook)*Orbiculoidea* species 1

524oa. Contadero Formation (middle)

Same as locality 524o.

Tylothyris compacta new species

524p. Oñate Formation (upper 2 feet of Bed D)

Same as locality 506y. Collectors: G. A. Cooper and J. T. Dutro.

Ambocoelia species 4*Nervostrophia plana* new species*Rhyssochonetes johnsoni* new species

524q. Oñate Formation (Bed A of Cooper)

San Andres Canyon (=loc. 523s).

Ambocoelia species 4*Emanuella* species*Nervostrophia plana* new species*Rhyssochonetes johnsoni* new species*Schizophoria lata* Stainbrook

524r. Oñate Formation (basal foot of Bed D)

Same as locality 506y.

Hypothyridina species*Rhyssochonetes johnsoni* new species

524s. Contadero Formation (Bed K)

Center NW¼SE¼ sec. 12, T. 17 S., R. 3 E., Deadman Canyon, San Andres Mountains, Kaylor Mountain (15') quadrangle, New Mexico. Collectors: J. T. Dutro and G. A. Cooper.

Douvillina contaderoensis new species*D. species* 2*Schizophoria amanaensis* Stainbrook*Stainbrookia rotunda* new species*Strophodonta umbonata* new species

524t. Contadero Formation (Bed K)

Same as locality 506w. Collectors: A. L. Bowsher and W. T. Allen.

Douvillina contaderoensis new species*Ripidiorhynchus newmexicoense* new species*Spinatrypa obsolescens* new species*Tylothyris* species 1

524u. Sly Gap Formation (Beds I–N)

Same as locality 524o. Collectors: G. A. Cooper and J. T. Dutro.

Athabascia? species 1*Calvinaria bransoni* Stainbrook*Cariniferella alleni* new species*Douvillinaria diversa* new species*Pseudoatrypa devoniana* (Webster)*Spinatrypa trulla decorticata* new subspecies

- 524u. (continued)
Strophonelloides parvulus new species
 (Float from Contadero Formation: *Cyrtospirifer pyramidalis* new species)
- 524w. Sly Gap Formation
 Sierra Caballo Mountains, north of saddle at fault, New Mexico.
 Collector: F. V. Stevenson.
Calvinaria bransoni Stainbrook
Costatrypa varicostata (Stainbrook)
Hypothyridina emmonsii rotunda new subspecies
Indospirifer anomala new species
Productella rugatula Stainbrook
Pseudoatrypa devoniana (Webster)
Tylothyris sulcocostata new species
- 524x. Oñate Formation (Sly Gap, mixed)
 NE¼SE¼ sec. 22, T. 17 S., R. 4 W., Upham (15') quadrangle, New Mexico. Collector: F. V. Stevenson.
Ambocoelia species 4
Aulacella elliptica new species
Emanuella species
Leiorhynchus sphaericum new species
Schizophoria lata Stainbrook
Warrenella floweri new species
- 524y. Sly Gap Formation
 Dry Canyon, off Gordon Canyon, SE¼SW¼ sec. 2, T. 17 S., R. 10E., 0.5 mile south of junction with Caballero Canyon, Alamo Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson.
Cariniferella alleni new species
Cyrtina inulta Stainbrook
- 524z. Rhodes Canyon Formation (Bed P)
 Same as locality 506w.
Crinisarina reticulata (Stainbrook)
Cupularostrum? stvensoni new species
Cyrtospirifer pyramidalis new species
Tylothyris novamexicana Stainbrook
- 526a. Contadero Formation
 Sec. 8, T. 17 S., R. 4 E., Deadman Canyon, San Andres Mountains, Kaylor Mountain (15') quadrangle, New Mexico. Collector: F. V. Stevenson.
Aulacella elliptica new species
Crinisarina reticulata (Stainbrook)
Cupularostrum? stvensoni new species
Douvillina contaderoensis new species
D. species 2
Schizophoria amanaensis Stainbrook
Stainbrookia rotunda new species
- 526b. Oñate Formation
 N½NW¼ sec. 19, T. 13 S., R. 8 W., 2 miles N. 60° E. of Hermosa, Sugar Loaf Peak (15') quadrangle, New Mexico. Collectors: G. A. Cooper and J. T. Dutro.
Ambocoelia species 4
Devonochonetes? species
Emanuella species
Hypothyridina species
Nervostrophia plana new species
Rhysochonetes johnsoni new species
- 526c. Oñate Formation (Bed D)
 Same as locality 526b. Collectors: G. A. Cooper and J. T. Dutro.
Cyrtina variabilis new species
Desquamatia costata new species
Dichacaenia umbonata new species
Hypothyridina species
- Nervostrophia plana* new species
Schizophoria lata Stainbrook
- 526d. Sly Gap Formation (Bed E-7 feet below top)
 Same as locality 526b. Collectors: G. A. Cooper and J. T. Dutro.
Costatrypa varicostata (Stainbrook)
Douvillina diversa new species
Nervostrophia geniculata new species
N. mucrospina new species
Thomasaria demissa new species
- 526e. Sly Gap Formation
 0.7 mile S. 10° E. of Nackaye Mines, 4 miles N. 73° E. of Derry, SE¼SW¼ sec. 22, T. 17 S., R. 4 W., Upham (15') quadrangle, New Mexico.
Aulacella elliptica new species
Calvinaria bransoni Stainbrook
Costatrypa varicostata (Stainbrook)
Strophodonta species 2
Tylothyris sulcocostata new species
- 526f. Sly Gap Formation
 Deadman Canyon, 3 miles southwest of Alamogordo, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico (=loc. 521o).
Douvillina parviuscula new species
Gypidula bowsheri new species
Pseudodouvillina euglyphea Stainbrook
Spinatrypa trulla decorticata new subspecies
- 526g. Contadero Formation
 Rhodes Canyon, same as locality 506w.
Ambocoelia species 2
Cupularostrum? stvensoni new species
Cyrtina inulta Stainbrook
Cyrtospirifer whitneyi (Hall)
Devonoproductus intermedius new species
Douvillina contaderoensis new species
D. species 2
Ripidiorhynchus newmexicoense new species
Schizophoria species indeterminate
Spinatrypa obsolescens new species
Tylothyris species 1
- 526h. Oñate Formation (middle)
 W½SW¼ sec. 7, T. 16 S., R. 11 E., first canyon north of Pig Canyon, Sacramento Mountains, 6 miles east of Alamogordo, Alamogordo (15') quadrangle, New Mexico.
Desquamatia costata new species
Mucrospirifer parvus new species
Nervostrophia plana new species
Platyerorhynchus obscurum new species
Striatochonetes nanus new species
Trigonoglossa? species
- 526i. Oñate Formation
 Nackaye Mines, same as locality 523d.
Warrenella magna new species
- 526j. Oñate Formation
 Derry Hills, same as locality 523f.
Schizophoria lata Stainbrook
- 526k. Sly Gap Formation
 SE¼NE¼ sec. 2, and SW¼NW¼ sec. 1, T. 17 S., R. 10 E., Alamo Canyon, Alamogordo (15') quadrangle, New Mexico.
Acutathea prolifica new species
Ambocoelia species 1
Aulacella elliptica new species
Calvinaria bransoni Stainbrook
Cariniferella alleni new species

526k. (continued)

- Coeloterorhynchus magnificus* new species
Cyrtina inulta Stainbrook
Devonoproductus intermedius new species
Hypothyridina emmonsii rotunda new subspecies
Nervostrophia solida new species
Pseudoatrypa devoniana (Webster)
Pseudodouvillina euglyphea Stainbrook
Schizophoria amanaensis Stainbrook
Spinatrypa trulla decorticata new subspecies
Sulcatostrophia calvini (Miller)
Thomasaria warreni new species

526l. Sly Gap Formation

Same as locality 506y.

- Coeloterorhynchus magnificus* new species

526m. Sly Gap Formation

First Canyon south of Alamo Canyon, Alamogordo (15') quadrangle. Collector: F. V. Stevenson.

- Cyrtina inulta* Stainbrook
Douvillina parviuscula new species
Douvillinaria variabilis (Calvin)
Thomasaria warreni new species

526n. Sly Gap Formation

Alamo Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson (=loc. 521p).

- Cyrtina inulta* new species
Devonoproductus intermedius new species
Productella rugulata Stainbrook

526o. Oñate Formation

Pig Canyon, same as locality 521l.

- Platyterorhynchus obscurum* new species

526p. Oñate Formation

SE corner NE¼SW¼ sec. 3, T. 17 S., R. 10 E., Deadman Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico. Collector: A. L. Bowsher (=loc. 3013).

- Platyterorhynchus obscurum* new species

526q. Sly Gap Formation

North branch of Marble Canyon, Sacramento Mountains, east of Alamogordo, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

- Cyrtina inulta* Stainbrook
Indospirifer exfoliata new species

526r. Sly Gap Formation

First unnamed canyon north of Marble Canyon, Sacramento Mountains, east of Alamogordo, Alamogordo (15') quadrangle, New Mexico.

- Aulacella elliptica* new species
Nervostrophia geniculata new species

526s. Sly Gap Formation

North side of Capitol Peak, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico.

- Costatrypa varicostata* (Stainbrook)
C. extensa new species
Nervostrophia mucrospina new species
Pseudoatrypa devoniana (Webster)
Spinatrypa trulla decorticata new subspecies

526t. Independence Shale Formation

Quarry at Brandon, Iowa. Collector: M. A. Stainbrook.

- Gypidula cornuta* Fenton and Fenton
G. stainbrookii new species

526u. Independence Shale Formation

Benton County highway 71, 0.25 mile south of Iowa highway 283, 0.5 mile east of Brandon, Iowa.

- Cariniferella costellata* new species

526v. Oñate Formation

NW corner, sec. 3, T. 17 S., R. 10 E., Sacramento Mountains, southeast of Alamogordo, Alamogordo (15') quadrangle, New Mexico. Collector: L. C. Pray.

- Platyterorhynchus obscurum* new species

526w. Independence Shale Formation

Poor Farm, one mile northeast of Independence, Iowa.

- Stainbrookia infera* (Calvin)

526x. Sly Gap Formation (Bed F)

Same as localities 506w, 3054.

- Coeloterorhynchus magnificus* new species
Tenticospirifer cf. *T. cyrtinaformis* (Hall and Whitfield)

526y. Independence Shale Formation

West Amana, Iowa. Collector: M. A. Stainbrook.

- Nervostrophia extensa* new species

526z. Oñate Formation

Bend of road near Little Tank, Johnson Park Canyon, S½NW¼ sec. 5, T. 10 S., R. 5 E., north end of San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collector: F. V. Stevenson. Mocking Bird Gap of F. V. Stevenson (1943, p. 222).

- Acutoria angulata* new species
Orthospirifer species

527a. Percha Formation (Box Member)

South side of Bear Mountain, along Bear Mountain road, SE¼ sec. 13 and SW¼ sec. 18, T. 17 S., R. 14 and 15 W., Silver City (7½') quadrangle, New Mexico.

- Cyrtiorina kindlei* (Stainbrook)
Cyrtospirifer animasensis (Girty)
C. convexus new species
C. rotundus new species
Hispidaria spinosa new species
Laminatia laminata (Kindle)
Leioproductus varispinosus (Stainbrook)
Paurohyncha cooperi Stainbrook
Petasmaria patens new species
Petrocrania ourayensis (Kindle)
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Sentosia praececedens (Stainbrook)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Thiemella platys new species

527b. Percha Formation (Box Member)

North of Bear Mountain road, center E½SE¼ sec. 13, T. 17 S., R. 15 W., southeast side of Bear Mountain, Silver City (7½') quadrangle, New Mexico. Collectors: R. E. Grant and G. A. Cooper.

- Schizophoria australis* Kindle

527c. Percha Formation (Box Member)

Lake Valley, Lake Valley quadrangle, New Mexico.

- Cyrtiorina kindlei* (Stainbrook)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle

527d. Percha Formation (Box Member)

Wilson Ranch, NE¼NW¼NW¼ sec. 11, T. 18 S., R. 7 W., Hillsboro (15') quadrangle, New Mexico. Collectors: F. V. Stevenson, A. L. Bowsher and W. T. Allen.

- Composita bellula* Stainbrook
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer convexus new species
Galeatella galeata Muir-Wood and Cooper
Hispidaria spinosa new species
Laminatia laminata (Kindle)

527d. (continued)

Leioproductus pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Petrocrania ourayensis (Kindle)
Planoproductus hillsboroensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Retichonetes perchaensis new species
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Sentosia praecedens (Stainbrook)
S. spinigera (Kindle)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)

527e. Percha Formation (Box Member)

Bear Mountain road, 5.4 miles north of junction of Alabama and Atlantic Streets, Silver City, Silver City (7½') quadrangle, New Mexico. Collector: F. V. Stevenson.

Acanthatia nupera (Stainbrook)
Athyris transversa (Stainbrook)
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer convexus new species
Hispidaria spinosa new species
Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle
Sentosia praecedens (Stainbrook)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)
Trifidorostellum obscurum new species

527f. Percha Formation (Box Member)

New Mexico highway 180 (90), 5 miles east of Santa Rita, New Mexico.

Acanthatia nupera (Stainbrook)
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer convexus new species
Leioproductus plicatus (Kindle)
L. varispinosus (Stainbrook)
Petasmaria patens new species
Planoproductus hillsboroensis (Kindle)
Ptychomalotoechia sobrina (Stainbrook)
Retichonetes obscurus new species
Schizophoria australis Kindle
Sentosia spinigera (Kindle)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)

527g. Percha Formation (Box Member)

Chloride Flat, 1.5 miles by road west of Silver City, Silver City (7½') quadrangle, New Mexico. Collector: F. V. Stevenson.

Cyrtiorina kindlei (Stainbrook)

Leioproductus plicatus (Kindle)

L. varispinosus (Stainbrook)

Paurorhyncha cooperi Stainbrook

Petasmaria patens new species

Ptychomalotoechia sobrina (Stainbrook)

Strophopleura notabilis (Kindle)

Syringospira prima Kindle

Toryniferella spinosa (Kindle)

527h. Percha Formation (Box Member)

0.6 mile N. 60° E. of Wilson Ranch, SW¼SW¼ sec. 2, T. 18 S., R. 7 W., Hillsboro (15') quadrangle, New Mexico.

Composita bellula Stainbrook

Petasmaria patens new species

Ptychomalotoechia sobrina (Stainbrook)

527i. Percha Formation (Box Member)

One mile north of Lake Valley, New Mexico.

Porostictia perchaensis (Stainbrook)

527j. Percha Formation (Box Member)

2 miles S. 50° E. of Hillsboro, Hillsboro (15') quadrangle, New Mexico. Collector: L. A. Nelson (=loc. 507h).

Strophopleura notabilis (Kindle)

Syringospira prima Kindle

527k. Percha Formation (Box Member)

0.3 mile west-southwest of J. P. Nunn Ranch, NW corner sec. 10, T. 17 S., R. 8 E., Hillsboro (15') quadrangle, New Mexico.

Syringospira prima Kindle

527l. Percha Formation (Box Member—upper 25 feet)

Bear Mountain, NE¼SE¼SE¼ sec. 13, T. 17 S., R. 15 W., Silver City (7½') quadrangle, New Mexico.

Athyris transversa (Stainbrook)

Leioproductus varispinosus (Stainbrook)

Ptychomalotoechia sobrina (Stainbrook)

Schizophoria australis Kindle

Strophopleura notabilis (Kindle)

527m. Same as locality 527l

527n. Percha Formation (Ready Pay Member)

Below the lowest cobbly limestone, 20–30 feet above the base of the green shale (top of black shale), west side of Bear Mountain, SE corner sec. 3, T. 17 S., R. 15 W., Silver City (7½') quadrangle, New Mexico. Collector: A. L. Bowsher.

Cyrtiorina kindlei (Stainbrook)

Petasmaria patens new species

527o. Percha Formation (Ready Pay Member)

15 feet above the base of the green shale or top of the black shale, northwest corner of Bear Mountain (=loc. 527n).

527p. Percha Formation (Box Member)

South side of Bear Mountain, NE¼SE¼ sec. 13, T. 17 S., R. 15 W., Silver City (7½') quadrangle, New Mexico. Collectors: G. A. Cooper and R. E. Grant (=loc. 507l).

Acanthatia nupera (Stainbrook)

Athyris transversa (Stainbrook)

Cyrtospirifer rotundus new species

Laminatia laminata (Kindle)

Leioproductus pauperculus new species

L. plicatus (Kindle)

L. varispinosus (Stainbrook)

Petasmaria patens new species

Planoproductus hillsboroensis (Kindle)

Retichonetes perchaensis new species

Schizophoria australis Kindle

Schuchertella percha (Stainbrook)

Sentosia praecedens (Stainbrook)

Strophopleura notabilis (Kindle)

Syringospira prima Kindle

Thiemella platys new species

- 527q. Contadero Formation
South side of Hembrillo Canyon, San Andres Mountains, Kaylor Mountain (15') quadrangle, New Mexico. Collector: R. Flower.
Thiemella quadrata new species
- 527r. Sly Gap Formation
Sly Gap, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico (=loc. 521d).
Aulacella elliptica new species
- 527s. Independence Shale Formation
Lime Creek, 1.25 miles northeast of Brandon, Iowa.
Strophonelloides deeringi Stainbrook
- 527t. Sly Gap Formation (lower 30 feet)
Rhodes Canyon, San Andres Mountains, Black Top Mountain (15') quadrangle, New Mexico. Collector: R. Flower.
Strophonelloides dorsoconvexus new species
- 527u. Oñate Formation
Rhodes Canyon, San Andres Mountains, Black Top Mountain (15') quadrangle, New Mexico. Collector: R. Flower.
Nervostrophia plana new species
- 527v. Contadero Formation (Coral Bed)
Sly Gap, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collector: R. Flower.
Douvillina species 2
- 527w. Oñate Formation
Hermosa, same as locality 526b. Collector: R. Flower.
Devonochonetes? species
- 527x. Oñate Formation (basal 5 feet)
Hermosa, same as locality 526b. Collector: R. Flower.
Rhysochonetes johnsoni new species
- 527y. Hackberry Formation (Cerro Gordo Member—*Strophonella* Zone)
0.4 mile south of Bird Hill, in ditch, 5 miles west of Rockford, Floyd County, Iowa. Donor: C. O. Levorson, Riceville, Iowa.
Eostrophalosia rockfordensis (Hall and Clarke)
- 527z. Rhodes Canyon Formation
Rhodes Canyon, San Andres Mountains, Black Top Mountain (15') quadrangle, New Mexico. Collectors: R. Flower and F. V. Stevenson.
Productella species 1
- 528a. Contadero Formation
Same as locality 527z. Collector: R. Flower.
Afilasma inexpectatum new species
Ripidiorhynchus newmexicoense new species
- 528b. Contadero Formation
Just below the purple shale, north side of Hembrillo Canyon, San Andres Mountains, Kaylor Mountain (15') quadrangle, New Mexico. Collector: R. Flower.
Colophragma ellipticum new species
- 528c. Rhodes Canyon Formation
East end of Rhodes Pass, San Andres Mountains, Black Top Mountain (15') quadrangle, New Mexico. Collector: M. A. Stainbrook.
Crinisarina reticulata (Stainbrook)
Cyrtospirifer breviposticus Stainbrook
Evanescirostrum glabraventrum (Stainbrook)
Tylothyrus novamexicana Stainbrook
- 528d. Hackberry Formation (Cerro Gordo Member)
Tile Yard, southwest of Rockford, Floyd County, Iowa. Collector and Donor: C. O. Levorson, Riceville, Iowa.
Calvinaria bransoni Stainbrook
- 528e. Same as locality 522f.
Desquamatia costata new species
- 528f. Independence Shale Formation
Cedar River, 2.5 miles south and 1.5 miles due west of Brandon, Iowa. Collector: M. A. Stainbrook.
Iowatrypa americana (Stainbrook)
- 528g. Contadero Formation
Same as locality 527v. Collector: R. Flower.
Spinatrypa compacta new species
- 528h. Independence Formation
West Amana, Iowa County, Iowa. Collector: C. H. Belanski
Spinatrypa trulla (Stainbrook)
- 528i. Oñate Formation
Lost Canyon, Hermosa, Sugarloaf Peak (15') quadrangle, New Mexico. Collector: R. Flower.
Emanuella species
- 528j. Rhodes Canyon Formation
Rhodes Canyon, same locality as 527u. Collector: R. Flower.
Cranaena navicella (Hall)
Crinisarina reticulata (Stainbrook)
Cyrtospirifer pyramidalis new species
Tylothyrus novamexicana Stainbrook
- 528k. Oñate Formation
Engle Camp, Hermosa, Sugarloaf Peak (15') quadrangle, New Mexico. Collector: R. Flower.
Mucrospirifer parvus new species
- 528l. Independence Shale Formation
Brandon, Iowa. Collector: M. A. Stainbrook.
Thomasaria altumbona Stainbrook
- 528m. Independence Formation
Same as locality 526t.
Thomasaria altumbona Stainbrook
- 528n. Oñate Formation (above *Chonetes* Bed)
Same as locality 526b. Collector: R. Flower
Cyrtina variabilis new species
- 528o. Probably Contadero Formation
Sly Gap section, same as locality 509o. Collector: R. Flower.
Productella? species 2
- 528p. Sly Gap Formation (2 feet above "*Chonetes*")
Hermosa, same as locality 526b. Collector: R. Flower.
Costatrypa varicostata (Stainbrook)
Thomasaria demissa new species
- 528q. Contadero Formation (Zone G)
Same as localities 521e, 521j. Collector: F. V. Stevenson.
Tylothyrus species 1
- 528r. Sly Gap Formation
Same as locality 523p.
Hypothyridina emmonsii rotunda new subspecies
- 528s. Oñate Formation
Same as locality 509p.
Hypothyridina species
- 528t. Oñate Formation ("*Spirifer*" beds)
Johnson Park Canyon, north end of the San Andres Mountains, Capitol Peak (15') quadrangle. New Mexico.
Mucrospirifer? cf. *M.?* *sculptilis* (Hall)
Nervostrophia plana new species
Acutoria angulata new species
- 528u. Oñate Formation
Alamo Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson (=loc. 529j).
Platytroterhynchus obscurum new species
- 528v. Sly Gap Formation (below lowest occurrence of the coral *Macgeea*)

528v. (continued)

Sly Gap, San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collector: R. Flower.

Rhipidomella species 1

528w. Sly Gap Formation

Alamo Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Schizophoria amanaensis Stainbrook

528x. Sly Gap Formation

East side of Alamo Peak, ½ mile west of Holmes Mine, center E½NW¼NE¼SE¼ sec. 25, T. 16 S., R. 10 E., Lincoln Forest Service Map, east of Alamogordo, New Mexico. Collector: A. L. Bowsher.

Strophonelloides parvulus new species

528y. Sly Gap Formation

Deadman Canyon, San Andres Mountains, sec. 8, T. 17 S., R. 4 E., Kaylor Mountain (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Aulacella elliptica new species

Douvillina parviuscula new species

Nervostrophia solida new species

Schizophoria amanaensis Stainbrook

Thomasaria demissa new species

529g. Oñate Formation (lower 5 feet)

Johnson Park Canyon, north end of San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico (=loc. 528t).

Mucrospirifer? cf. *M.?* *sculptilis* (Hall)

Nervostrophia plana new species

Spinocyrtia? species

Tropidoleptus platys new species

529i. Sly Gap Formation

15 feet below the base of the Mississippian, Johnson Park Canyon, Capitol Peak (15') quadrangle, New Mexico.

Ambocoelia species 4

529j. Oñate Formation

Alamo Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Desquamatia costata new species

Dichacaenia umbonata new species

Mucrospirifer parvus new species

Platyterorhynchus obscurum new species

Striatochonetes nanus new species

529k. Oñate Formation (6–8 feet below the top)

Deadman Canyon, Sacramento Mountains, Alamogordo (15') quadrangle, New Mexico.

Desquamatia costata new species

Nervostrophia plana new species

Platyterorhynchus obscurum new species

529l. Oñate Formation

Nackaye Mines, northeast of Derry, Upham (15') quadrangle, New Mexico (=loc. 523d).

Ambocoelia species 4

529m. Oñate Formation

Agua Chichita Canyon, Sacramento Mountains, New Mexico. Collector: F. V. Stevenson.

Ambocoelia species 4

Nervostrophia plana new species

Rhyssochonetes johnsoni new species

529n. Oñate Formation

2.5 miles up Alamo Canyon from its mouth, Alamogordo (15') quadrangle, New Mexico.

Lingula species 3

Nervostrophia plana new species

Platyterorhynchus obscurum new species

Striatochonetes nanus new species

529o. Oñate Formation

Fault block, Marble Canyon, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Desquamatia costata new species

Mucrospirifer parvus new species

529p. Sly Gap Formation

Same as locality 526b.

Costatrypa varicostata new species

Thomasaria demissa new species

529q. Oñate Formation (upper)

Deadman Canyon, center NW¼SE¼ sec. 12, T. 17 S., R. 3 E., Kaylor Mountain (15') quadrangle, New Mexico.

Platyterorhynchus obscurum new species

529r. Oñate Formation

Marble Canyon, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Lingula species 4

529s. Sly Gap Formation (Bed I)

Center NW¼SE¼ sec. 12, T. 17 S., R. 3 E., Deadman Canyon, San Andres Mountains, Kaylor Mountain (15') quadrangle, New Mexico.

Cariniferella allenii new species

Coeloterorhynchus magnificum new species

Cyrtina inulta Stainbrook

Elita magister new species

Spinatrypa trulla decorticata new subspecies

529t. Oñate Formation (Bed C)

Bear Canyon, Lake Lucero SW (7½') quadrangle, New Mexico.

Platyterorhynchus obscurum new species

529u. Sly Gap Formation

South side of Deadman Canyon, San Andres Mountains, center W½ sec. 8, T. 17 S., R. 4 W., Kaylor Mountain (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Costatrypa varicostata (Stainbrook)

529v. Sly Gap Formation

San Andres Canyon, San Andres Mountains, New Mexico.

Pseudoatrypa devoniana (Webster)

529w. Oñate Formation

Arcente Canyon, Alamogordo (15') quadrangle, New Mexico. Collector: F. V. Stevenson.

Ambocoelia species 4

Platyterorhynchus obscurum new species

Rhipidomella species 2

529x. Sly Gap Formation (10–14 feet above the Oñate)

Same as locality 506c.

Calvinaria bransoni Stainbrook

Coeloterorhynchus magnificum new species

529y. Sly Gap Formation (Bed A—5–10 feet above base)

N½SW¼ sec. 9, T. 12 S., R. 7 W., 2 miles N. 60° W. of Chise, Sierra County (1960) map, New Mexico.

Costatrypa extensa new species

C. varicostata (Stainbrook)

Schizophoria amanaensis Stainbrook

USGS 459. Percha Formation (Box Member)

Northeast of Santa Rita, New Mexico. Collector: H. A. Thorne.

Cyrtiorina kindlei (Stainbrook)

USGS 460. Percha Formation (Box Member)

Mining District, Kingston, New Mexico. Collector: L. C. Graton.

Paurorhyncha cooperi Stainbrook

Petasmaria patens new species

USGS 461. Percha Formation (Box Member)

Same as locality 507h. Collector: L. C. Graton.

USGS 508. Percha Formation (Box Member)
Silver City quadrangle, New Mexico. Collectors: G. H. Girty and S. Paige.

Acanthatia nupera (Stainbrook)
Laminatia laminata (Kindle)
Leioproductus plicatus (Kindle)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Schizophoria australis Kindle
Strophopleura notabilis (Kindle)
Toryniferella spinosa (Kindle)

USGS 509. Percha Formation (Box Member)
Silver City quadrangle, New Mexico. Collectors: G. H. Girty and S. Paige.

Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer rotundus new species
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Strophopleura notabilis (Kindle)

USGS 510. Percha Formation (Box Member)
Silver City quadrangle, New Mexico. Collectors: G. H. Girty and S. Paige.

Sentosia praecedens (Stainbrook)

USGS 512. Percha Formation (Box Member)
Lake Valley, New Mexico. Collector and Donor: F. Springer.

Cyrtiorina kindlei (Stainbrook)
Leioproductus plicatus (Kindle)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Schizophoria australis Kindle
Toryniferella spinosa (Kindle)
Trifidorostellum obscurum new species

USGS 534. Sly Gap Formation
North slope of Sheep Mountain, San Andres Mountains, New Mexico. Collector: N. H. Darton.

Costatrypa varicostata (Stainbrook)
Devonoproductus intermedius new species
Thomasaria demissa new species

USGS 536. Sly Gap Formation
San Andres Canyon, San Andres Mountains, New Mexico. Collector: N. H. Darton.

Elita magister new species

USGS 538. Sly Gap Formation
One mile south of Capitol Peak, San Andres Mountains, New Mexico. Collector: N. H. Darton.

Costatrypa varicostata (Stainbrook)
C. extensa new species
Devonoproductus intermedius new species
Nervostrophia solida new species
N. mucrospina new species
Pseudoatrypa devoniana (Webster)

USGS 540. Oñate Formation
One mile south of Capitol Peak, San Andres Mountains, New Mexico. Collector: N. H. Darton.

Mucrospirifer? cf. *M.?* *sculptilis* (Hall)
Tropidoleptus platys new species

USGS 541. Sly Gap Formation
Hembrillo Canyon, San Andres Mountains, New Mexico. Collector: N. H. Darton.

Coeloterorhynchus magnificum new species
Gypidula bowscheri new species

USGS 543. Sly Gap Formation
Sulphur Gap, San Andres Mountains, New Mexico. Collector: N. H. Darton.

Aulacella elliptica new species

Coeloterorhynchus magnificum new species

Cyrtospirifer species 4

Douvillina parviuscula new species

USGS 4804 (Kindle). Percha Formation (Box Member)
Kingston, New Mexico. Collectors: G. H. Girty and S. Paige.
Syringospira prima Kindle

3013. Oñate Formation (6 feet below ruddy brown bed at top)
Deadman Canyon, same as locality 526p.

Platyterorhynchus obscurum new species

3016. Sly Gap Formation

Type section of the Sly Gap Formation, Sheep Mountain, sec. 25, T. 11 S., R. 15 E., San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collectors: W. T. Allen and A. L. Bowsher.

Aulacella elliptica new species

Nervostrophia mucrospina new species

3023. Oñate Formation (See 3023b, c, and d below)

3023b. Oñate Formation

One mile S. 6° W. of Little Tank, Johnson Park Canyon, S½NW¼ sec. 5, T. 10 S., R. 5 E., north end of San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collector: A. L. Bowsher (=loc. 526z). For conodonts see USGS loc. 9208-SD.

Mucrospirifer? cf. *M.?* *sculptilis* (Hall)

Tropidoleptus platys new species

3023c. Oñate Formation

One mile S. 6° W. of Little Tank, Johnson Park Canyon, S½NW¼ sec. 5, T. 10 S., R. 5 E., north end of San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collector: A. L. Bowsher (=loc. 526z).

Acutoria angulata new species

Cyrtina variabilis new species

Orthospirifer species

Pentamerella species

Platyterorhynchus obscurum new species

Schizophoria lata Stainbrook

3023d. Oñate Formation

One mile S. 6° W. of Little Tank, Johnson Park Canyon, S½NW¼ sec. 5, T. 10 S., R. 5 E., north end of San Andres Mountains, Capitol Peak (15') quadrangle, New Mexico. Collector: A. L. Bowsher (=loc. 526z).

Nervostrophia plana new species

3025. Sly Gap Formation

Same as locality 506y.

Nervostrophia solida new species

Hyborhynchella bransoni Cooper

3025a. Oñate Formation

Same as locality 506y.

Atryparia rubra new species

Eleutherokomma extensa new species

Hadorrhynchia alta new species

Leiorhynchus sphaericum new species

Platyterorhynchus obscurum new species

Striatochonetes nanus new species

3026. Percha Formation (Box Member)

0.6 mile N. 65° E. of Earl Wilson Ranch, SE¼SE¼SW¼ sec. 11, T. 18 S., R. 7 W., Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

Acanthatia nupera (Stainbrook)

Athyris transversa (Stainbrook)

Composita bellula Stainbrook

Cyrtiorina kindlei (Stainbrook)

Cyrtospirifer convexus new species

Galeatella galeata Muir-Wood and Cooper

Hispidaria spinosa new species

Leioproductus pauperculus new species

3026. (continued)

- L. plicatus* (Kindle)
L. varispinosus (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Petrocrania ourayensis (Kindle)
Planoproductus hillsboroensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Sentosia praecedens (Stainbrook)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)
Falciclymenia bowsheri (Miller and Collinson) 1951*

3026a. Percha Formation (Box Member)

West slope of scarp east of tank, 0.7 mile N. 60° E. of Earl Wilson Ranch, SW¼SW¼ sec. 2, T. 18 S., R. 7 W., Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

- Acanthatia nupera* (Stainbrook)
Athyris transversa (Stainbrook)
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer convexus new species
Galeatella galeata Muir-Wood and Cooper
Hispidaria posterogranulosa new species
H. spinosa new species
Laminatia laminata (Kindle)
Leioproductus plicatus (Kindle)
L. varispinosus (Stainbrook)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Petrocrania ourayensis (Kindle)
Planoproductus hillsboroensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Sentosia spinigera (Kindle)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)

3029. Percha Formation (Box Member)

East facing scarp on the west side of gap on Tierra Blanca Creek road, 2.2 miles N. 75° W. of J. P. Nunn Ranch, 1.2 miles N. 30° W. of Tierra Blanca Mountain, SE¼SE¼ sec. 5, T. 17 S., R. 8 W., Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

- Acanthatia nupera* (Stainbrook)
Ambocoelia capillata new species
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer rotundus new species
Eoparaphorhynchus mclareni Sartenaer
Leioproductus plicatus (Kindle)
L. varispinosus (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Planoproductus hillsboroensis (Kindle)
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle

- Sentosia praecedens* (Stainbrook)
Toryniferella spinosa (Kindle)
Trifidorostellum obscurum new species

3030. Percha Formation (Box Member)

North of Trujillo Creek, on west facing scarp along canyon running north from Trujillo Creek, 5 miles S. 50° E. of Hillsboro, center, south boundary, sec. 26, T. 16 S., R. 7 W., Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

- Composita bellula* Stainbrook
Cyrtiorina kindlei (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Ptychomalotoechia sobrina (Stainbrook)

3031. Percha Formation (Box Member)

Fork of Percha Creek, SW¼SE¼ sec. 9, and N½NE¼, sec. 16, T. 16 S., R. 8 W., Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

- Leioproductus varispinosus* (Stainbrook)
Retichonetes obscurus new species

3031a. Percha Formation (Box Member)

N½SW¼SE¼ sec. 9, T. 16 S., R. 8 W., Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

- Athyris transversa* (Stainbrook)
Cyrtiorina kindlei (Stainbrook)
Laminatia laminata (Kindle)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Schizophoria australis Kindle
Syringospira prima Kindle

3031b. Percha Formation (lower Box or uppermost Ready Pay members)

Gully on north side of road, SE¼NW¼SE¼ sec. 9, T. 16 S., R. 8 W., Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

- Composita bellula* Stainbrook
Cyrtiorina kindlei (Stainbrook)
Leioproductus varispinosus (Stainbrook)
Paurorhyncha cooperi Stainbrook
Ptychomalotoechia sobrina (Stainbrook)
Syringospira prima Kindle

3034. Percha Formation (Box Member)

Same as locality 507h.

3035. Percha Formation (Box Member)

0.44 mile west of Kingston and to the north of Ladrone Gulch, SE¼NW¼ sec. 18, T. 16 S., R. 8 W., Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

- Acanthatia nupera* (Stainbrook)
Athyris transversa (Stainbrook)
Cyrtiorina kindlei (Stainbrook)
Leioproductus plicatus (Kindle)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Planoproductus hillsboroensis (Kindle)
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Toryniferella spinosa (Kindle)

3037. Percha Formation (Ready Pay Member—basal 10–20 feet)

In gully, north side of road, 1.2 miles south of Wilson Ranch, Hillsboro (15') quadrangle, New Mexico. Collector: A. L. Bowsher.

- Lingulipora porifera* new species

3042. Percha Formation (Box Member)

Northwest slope of Bear Mountain, SW¼NW¼ sec. 11, T. 17 S., R. 15 W., Silver City (7½') quadrangle, New Mexico. Collector: A. L. Bowsher.

* This specimen, an ammonite, is in the National Museum of Natural History (USNM 116343). It is a rare but important specimen because it links the Box Member of the Percha to the *Clymenia* Zone of the German Devonian.

3042. (continued)

- Acanthatia nupera* (Stainbrook)
Athyris transversa (Stainbrook)
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer convexus new species
Galeatella galeata Muir-Wood and Cooper
Hispidaria posterogranulosa new species
H. spinosa new species
Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)
L. varispinosus (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Planoproductus hillsboroensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle
Schuchertella percha (Stainbrook)
Sentosia praecedens (Stainbrook)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)
Trifidorostellum obscurum new species

3042s. Percha Formation (Box Member)

East of Bear Mountain road, 0.9 mile southeast of Bear Mountain, E½ sec. 13, T. 17 S., R. 15 W., Silver City (7½') quadrangle, New Mexico. Collector: A. L. Bowshe.

- Athyris transversa* (Stainbrook)
Composita bellula Stainbrook
Cyrtiorina kindlei (Stainbrook)
Cyrtospirifer convexus new species
Laminatia laminata (Kindle)
Leioproductus pauperculus new species
L. plicatus (Kindle)
Oiosia putilla (Stainbrook)
Paurorhyncha cooperi Stainbrook
Petasmaria patens new species
Planoproductus hillsboroensis (Kindle)
Porostictia perchaensis (Stainbrook)
Ptychomalotoechia sobrina (Stainbrook)
Schizophoria australis Kindle
Sentosia praecedens (Stainbrook)
Strophopleura notabilis (Kindle)
Syringospira prima Kindle
Toryniferella spinosa (Kindle)
Trifidorostellum obscurum new species

3043. Percha Formation

Same as locality 509o.

3045. Sly Gap Formation

Arcente Canyon, west side road, 6.2 miles south of High Rolls, SE¼NW¼NE¼ sec. 20, T. 16 S., R. 11 E., Lincoln National Forest Service Map, New Mexico. Collector: A. L. Bowshe (=loc. 509m).

3045b. Sly Gap Formation

Arcente Canyon, west side of road, 6.2 miles south of High Rolls, SE¼NW¼NE¼ sec. 20, T. 16 S., R. 11 E., Lincoln National Forest Service Map, New Mexico: Collector: A. L. Bowshe (=loc. 509m).

- Acutatheca prolifica* new species
Gypidula bowsheri new species
Pseudodouvillina euglyphea Stainbrook
Thomasaria warreni new species

3045c. Sly Gap Formation

Arcente Canyon, west side of road, 6.2 miles south of High Rolls, SE¼NW¼NE¼ sec. 20, T. 16 S., R. 11 E., Lincoln National Forest Service Map, New Mexico. Collector: A. L. Bowshe (=loc. 509m).

Schizophoria amanaensis Stainbrook.

3045g. Sly Gap Formation

Arcente Canyon, west side of road, 6.2 miles south of High Rolls, SE¼NW¼NE¼ sec. 20, T. 16 S., R. 11 E., Lincoln National Forest Service Map, New Mexico. Collector: A. L. Bowshe (=loc. 509m).

Spinatrypa trulla decorticata new subspecies

3052a. Onate Formation

Pig Canyon Anticline, 1.8 miles N. 7° E. of Ortega Peak, 4 miles N. 80° E. of Alamogordo, SW¼NE¼SW¼ sec. 7, T. 16 S., R. 11 E., Lincoln Forest Service Map, New Mexico. Collector: A. L. Bowshe.

- Cyrtina variabilis* new species
Eleutherokomma extensa new species
Hadorhynchia mclareni new species
Platyterorhynchus obscurum new species

3053. Onate Formation (Zone I)

Same as locality 522d.

3054. Sly Gap Formation

0.25 mile north of Rhodes Canyon highway, SW¼ sec. 3, T. 13 S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico. Collector: A. L. Bowshe.

- Cariniferella allenii* new species
Costatrypa extensa new species
Spinatrypa trulla decorticata new subspecies

3054b. Sly Gap Formation

0.25 mile north of Rhodes Canyon highway, SW¼ sec. 3, T. 13 S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico. Collector: A. L. Bowshe.

- Costatrypa varicostata* Stainbrook
Cyrtina inulta Stainbrook
Strophodonta species 2

3054c. Sly Gap Formation

0.25 mile north of Rhodes Canyon highway, SW¼ sec. 3, T. 13 S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico. Collector: A. L. Bowshe.

- Costatrypa extensa* new species
Tylothyris sulcocostata new species

3054f. Sly Gap Formation

0.25 miles north of Rhodes Canyon highway, SW¼ sec. 3, T. 13 S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico. Collector: A. L. Bowshe.

- Calvinaria bransoni* Stainbrook
Douvillina parviuscula new species
Pseudoatrypa devoniana (Webster)

3054g. Sly Gap Formation

0.25 mile north of Rhodes Canyon highway, SW¼ sec. 3, T. 13 S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico. Collector: A. L. Bowshe.

Floweria prava (Hall)

3054h. Sly Gap Formation

0.25 mile north of Rhodes Canyon highway, NW¼ sec. 3, T. 13 S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico. Collector: A. L. Bowshe.

- Hyborhynchella bransoni* Cooper
Thomasaria warreni new species

3054i. Sly Gap Formation (beds with *Pachyphyllum*)

0.25 mile north of Rhodes Canyon highway, NW¼ sec. 3, T. 13

3054i. (continued)

S., R. 4 E., Black Top Mountain (15') quadrangle, New Mexico.

Collector: A. L. Bowsher.

Costatrypa varicostata (Stainbrook)

Elita magister new species

Schizophoria amanaensis Stainbrook

3054k. Contadero Formation

Same as locality 524t.

Ambocoelia species 2

Douvillina contaderoensis new species

Ripidiorhynchus newmexicoense new species

Spinatrypa obsolescens new species

3054q. Rhodes Canyon Formation

0.25 miles north of Rhodes Canyon highway, NW¼ sec. 3, T. 13

S. R. 4 E., Black Top Mountain (15') quadrangle, New Mexico.

Collector: A. L. Bowsher.

Crinisarina reticulata (Stainbrook)

Cyrtospirifer pyramidalis new species

Productella species 1

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PLATES



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3

EXPLANATION OF PLATE A

Oñate Formation

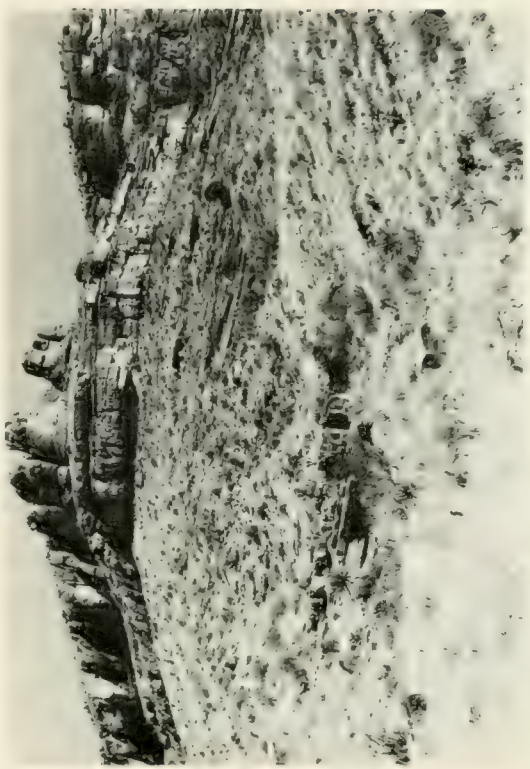
1. Oñate Formation, Alamo Canyon, Deadman Branch, Sacramento Mountains.
Photo by A. L. Bowsher.
2. Oñate Formation with fish bed on top (just below hammer), Bear Canyon, San Andres Mountains.
Photo by G. A. Cooper.
3. Oñate Formation, Pig Canyon, Sacramento Mountains.
Photo by A. L. Bowsher.
4. Oñate Formation, massive limestone (just below hammer), Nackaye Mines, Derry, New Mexico.
Photo by G. A. Cooper.

EXPLANATION OF PLATE B
Sly Gap Formation

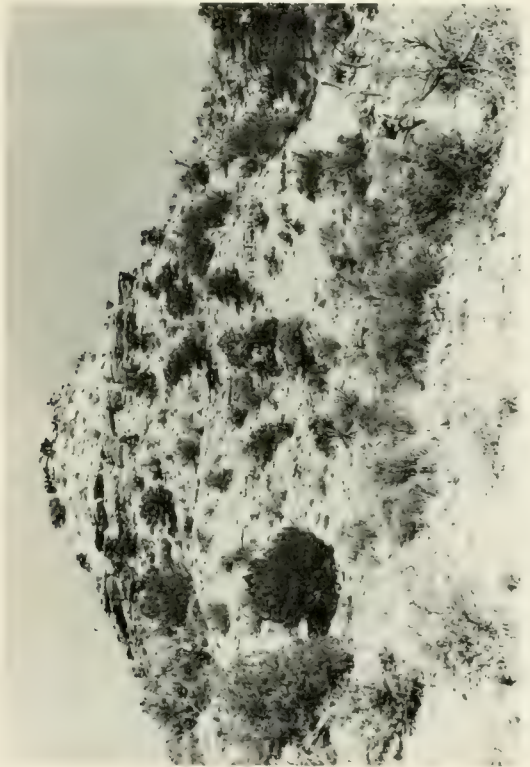
1. Conical hill of Sly Gap Formation, Alamo Canyon, Sacramento Mountains.
Photo by G. A. Cooper.
2. Nodular Sly Gap Formation, Hermosa, New Mexico.
Photo by G. A. Cooper.
3. Upper Sly Gap Formation, Deadman Canyon, San Andres Mountains.
Photo by G. A. Cooper.
4. Full section of Devonian, Deadman Canyon, San Andres Mountains.
Photo by G. A. Cooper.



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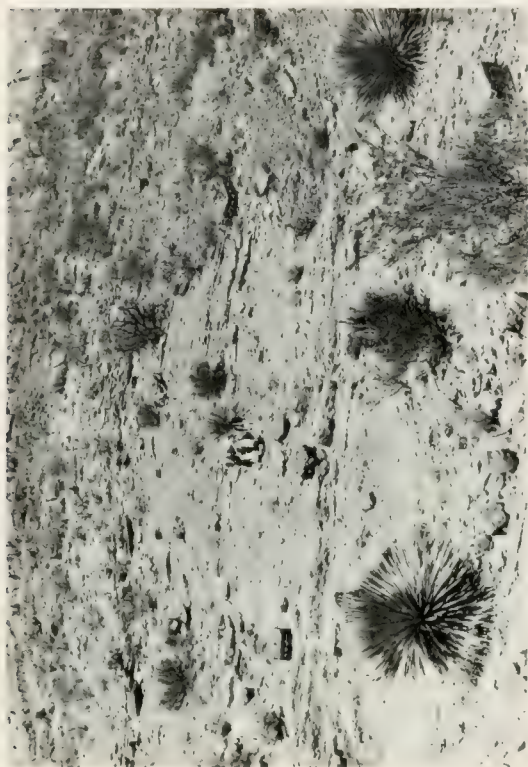
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EXPLANATION OF PLATE C
Devonian, Sheep Mountain

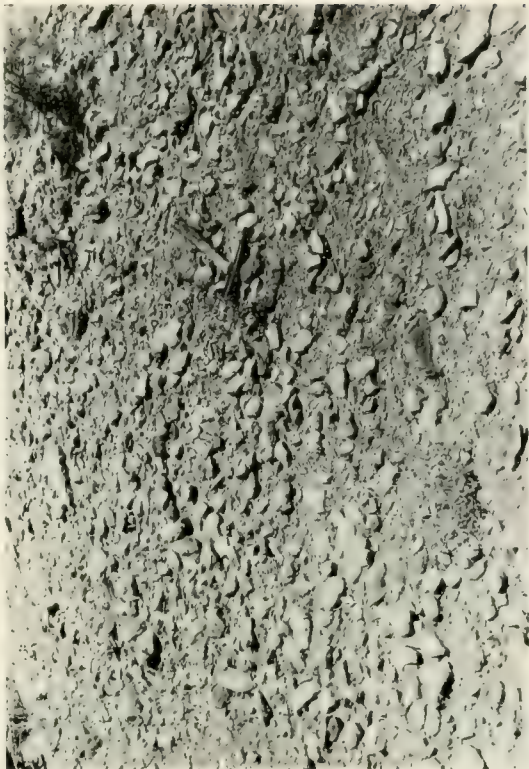
1. Sheep Mountain from the south, San Andres Mountains.
Photo by G. A. Cooper.
2. Shaly portion of the Sly Gap Formation, Sheep Mountain, San Andres Mountains.
Photo by G. A. Cooper.
3. Contadero Formation, Sheep Mountain, San Andres Mountains.
Photo by G. A. Cooper.
4. Thoroughgood Formation, Sheep Mountain, San Andres Mountains.
Photo by G. A. Cooper.

EXPLANATION OF PLATE D
Percha Formation

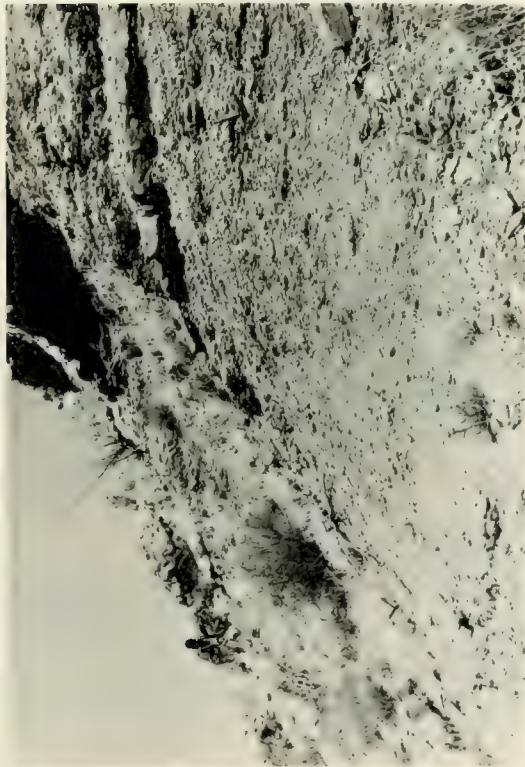
1. Percha Formation (Box Member), type section (locality 507h), southeast of Hillsboro, New Mexico.
Photo by G. A. Cooper.
2. Percha Formation (Ready Pay siltstone), Lone Mountain, Hurley, New Mexico.
Photo by G. A. Cooper.
3. Percha Formation (Box Member), full section at Georgetown, New Mexico.
Photo by G. A. Cooper.
4. Percha Formation (Box Member), nodules in lower part of member, Georgetown, New Mexico.
Photo by G. A. Cooper.



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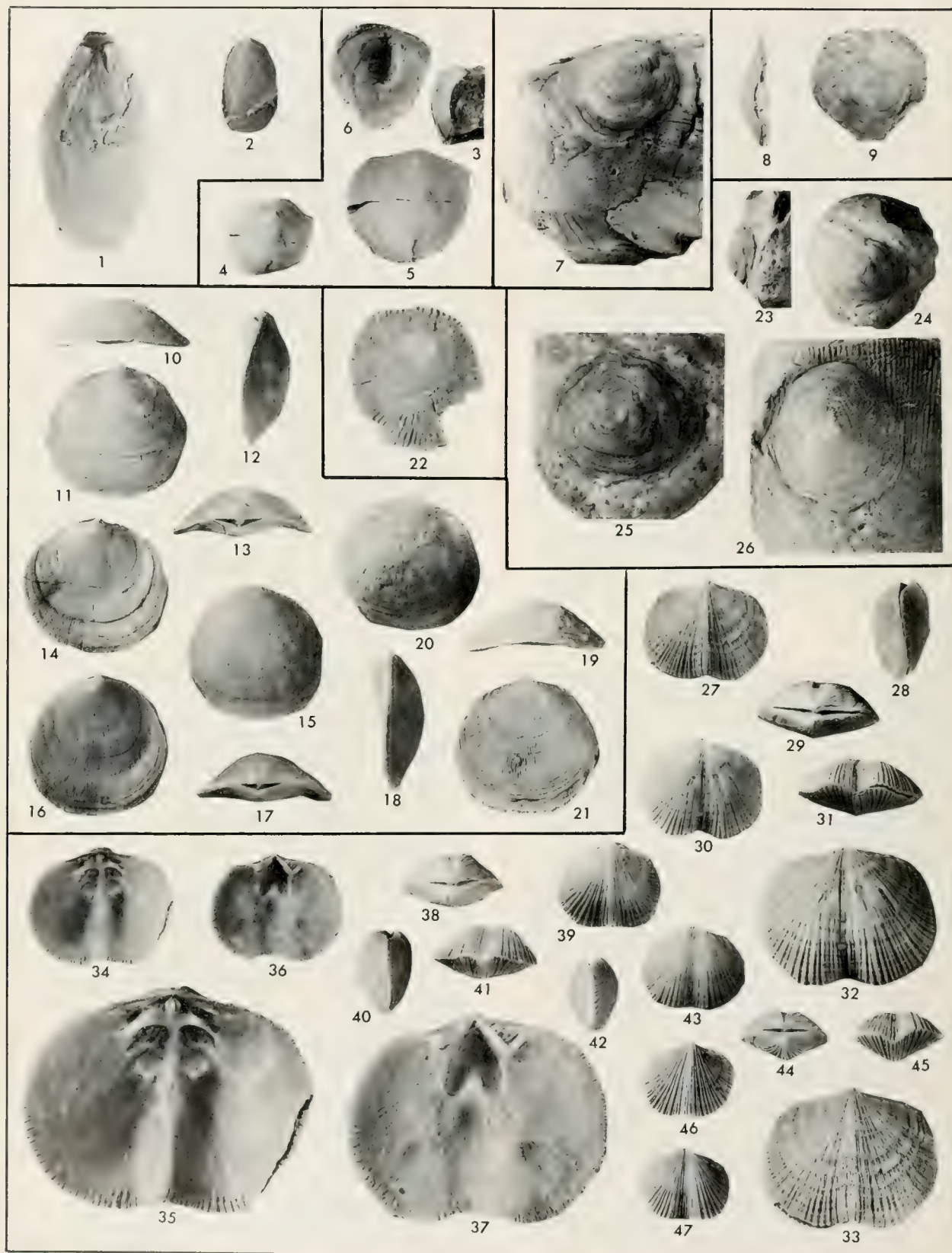
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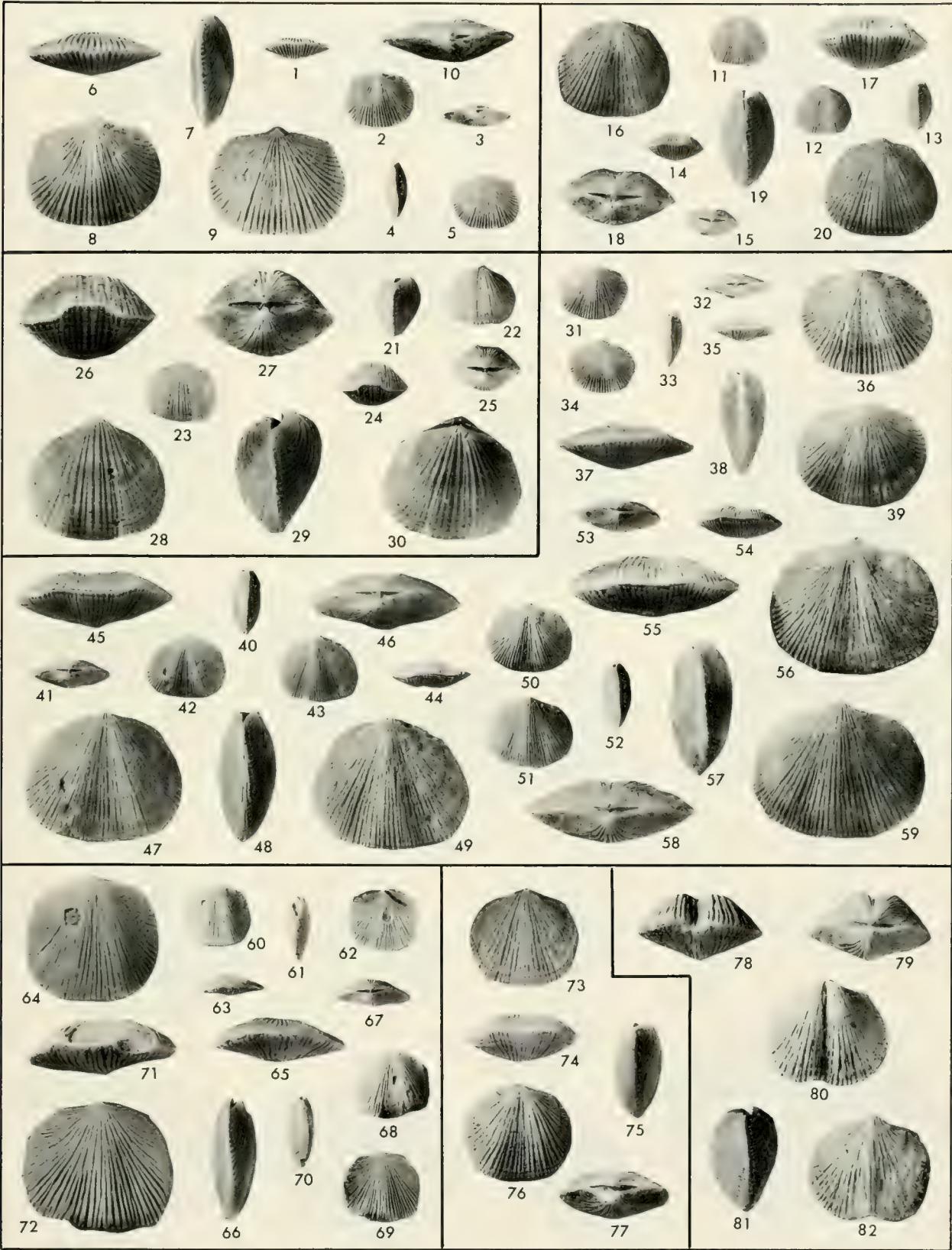


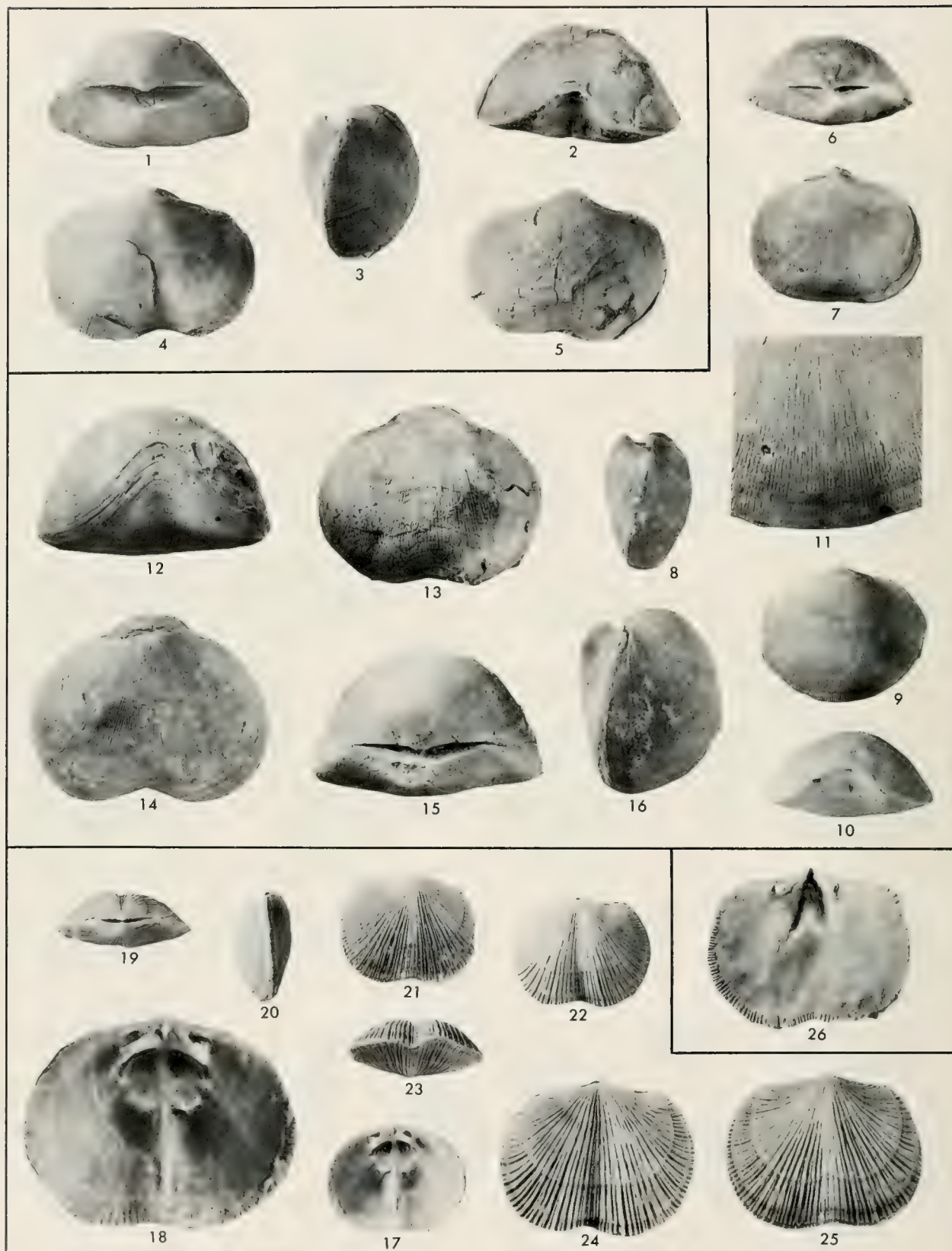
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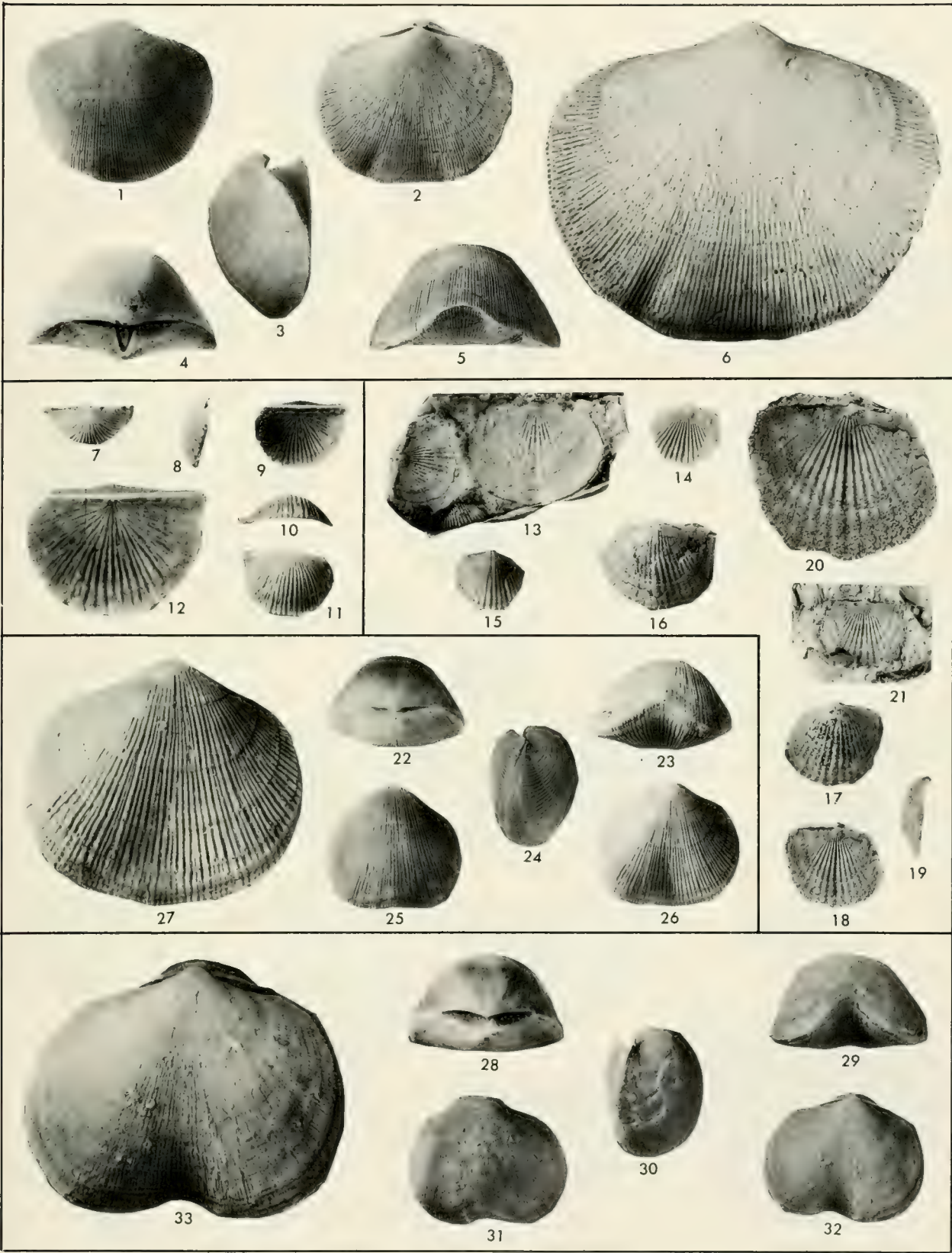


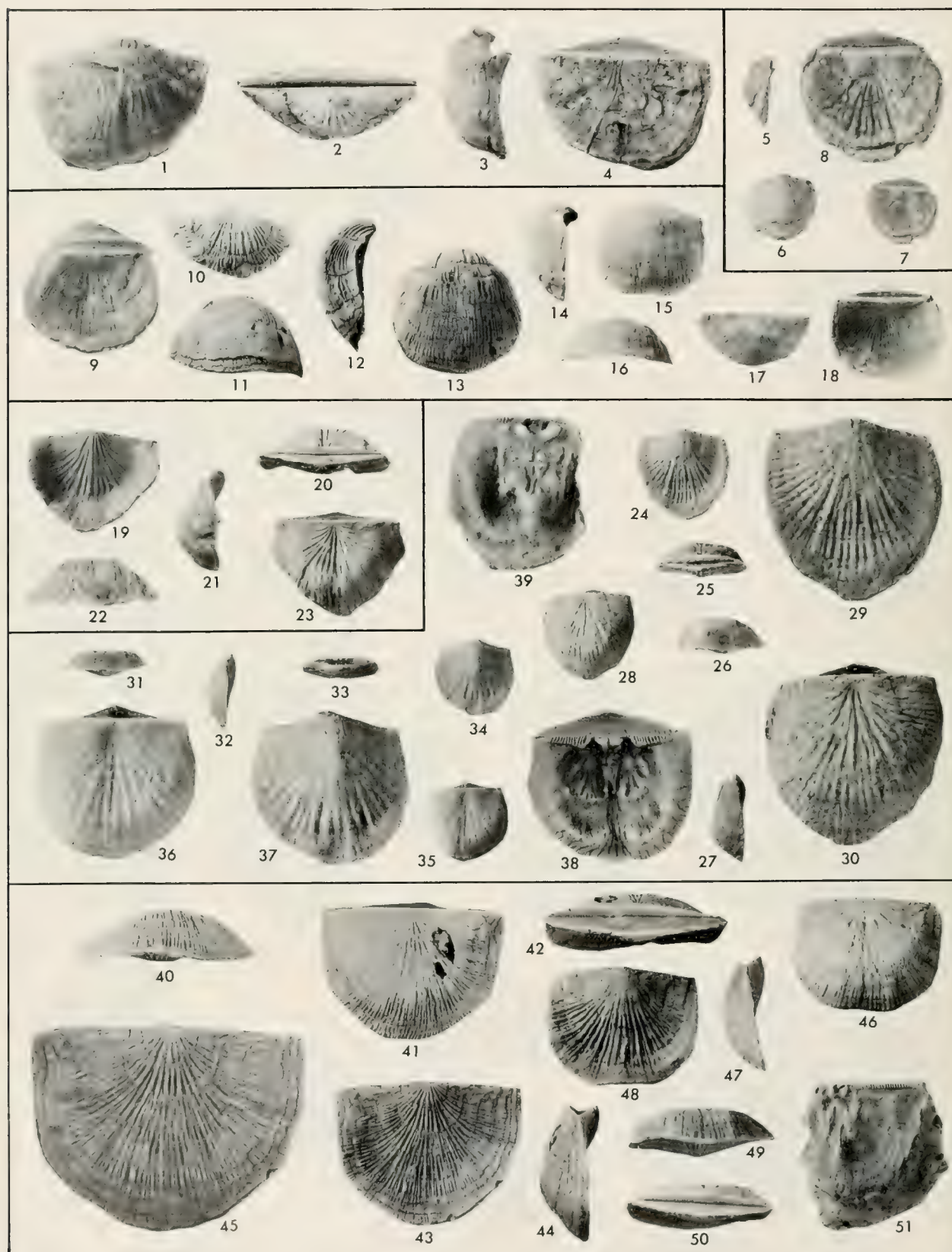
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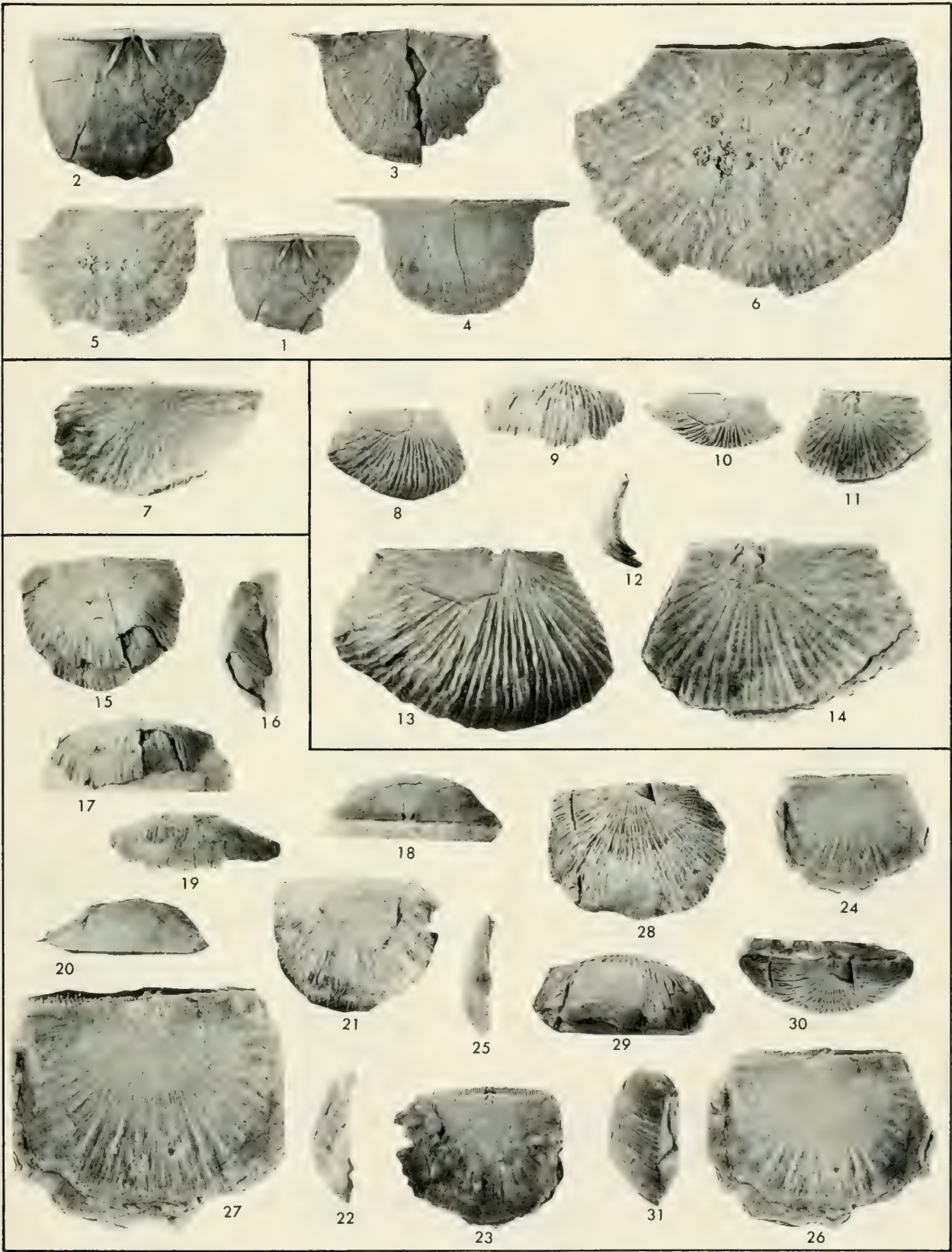


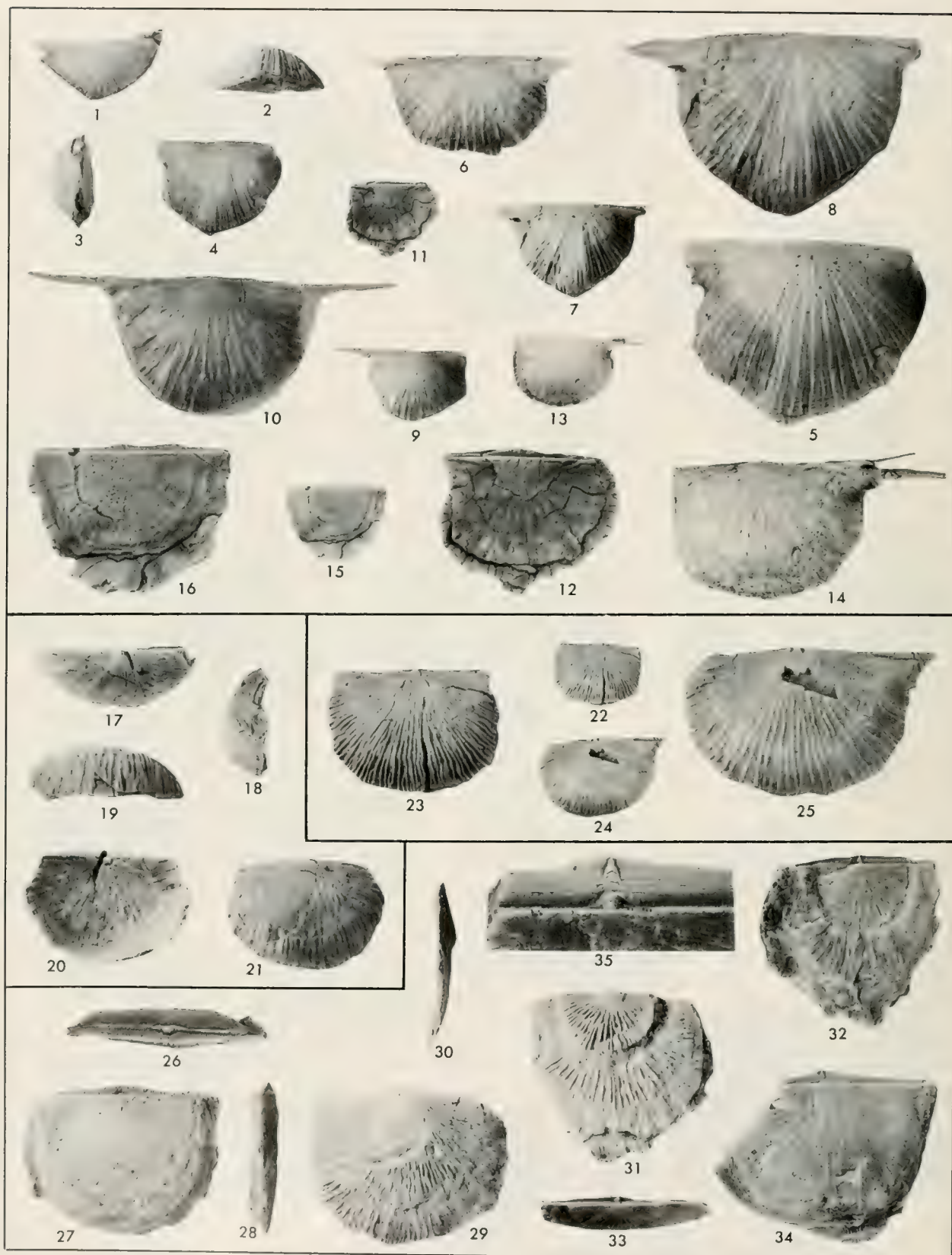
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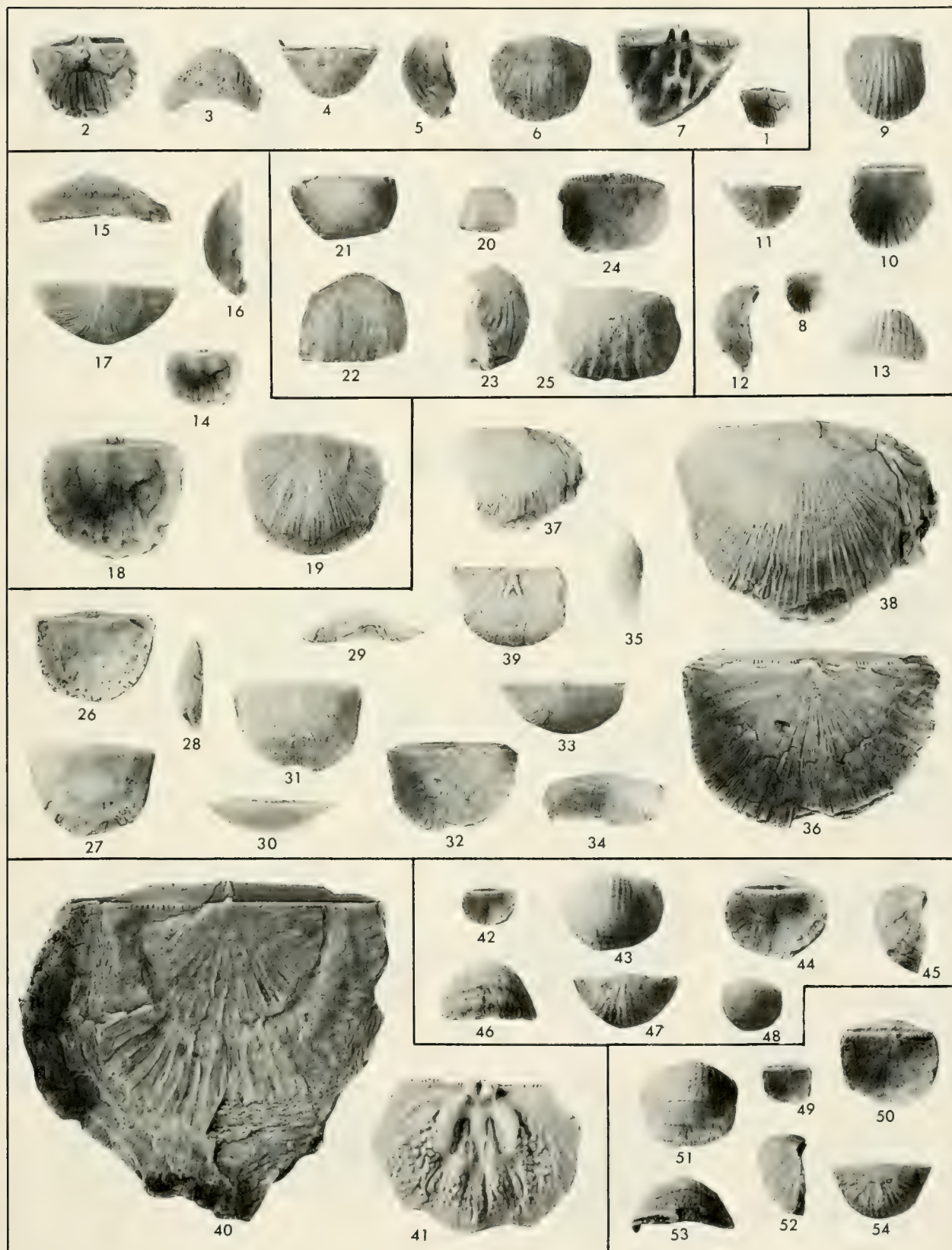


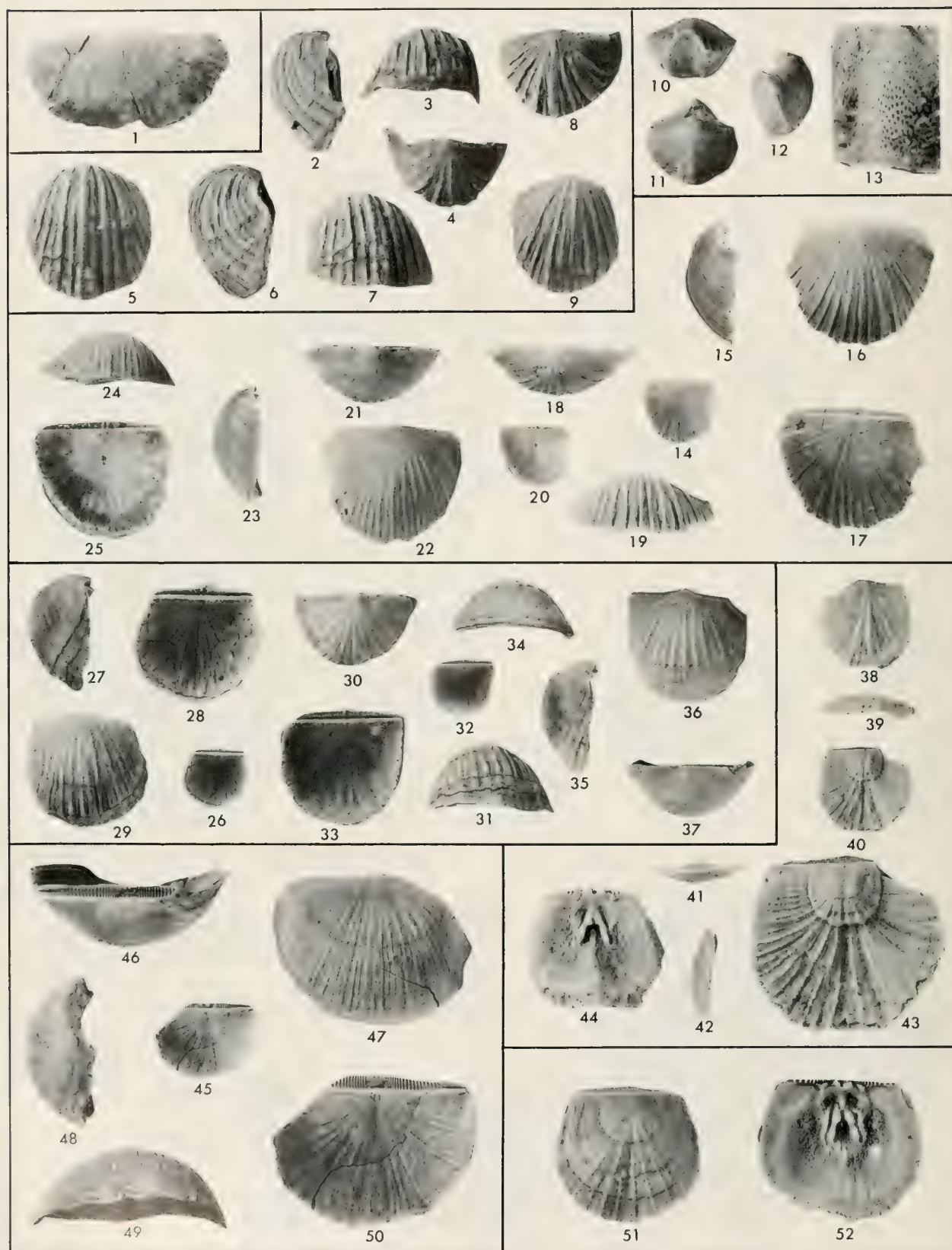
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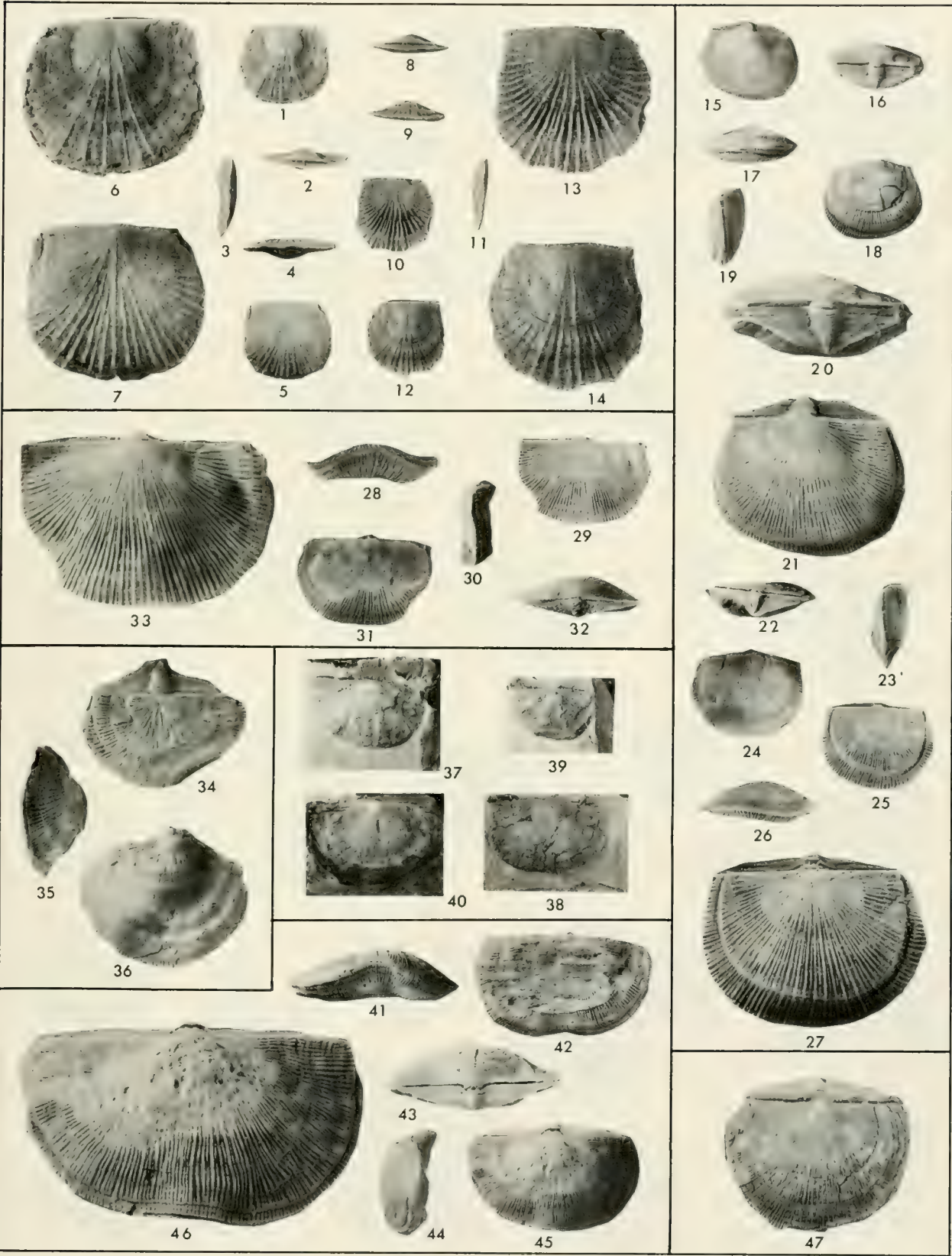


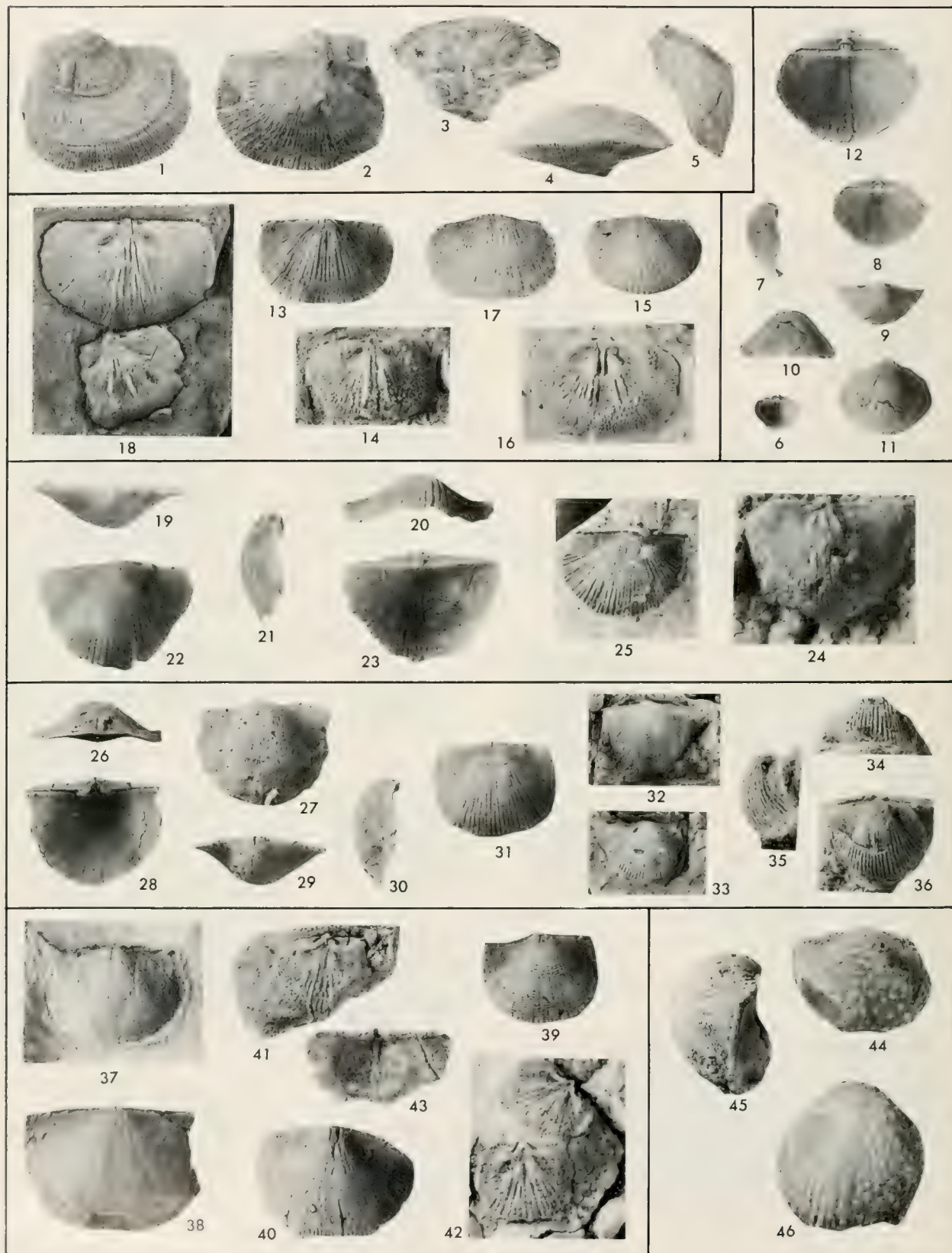
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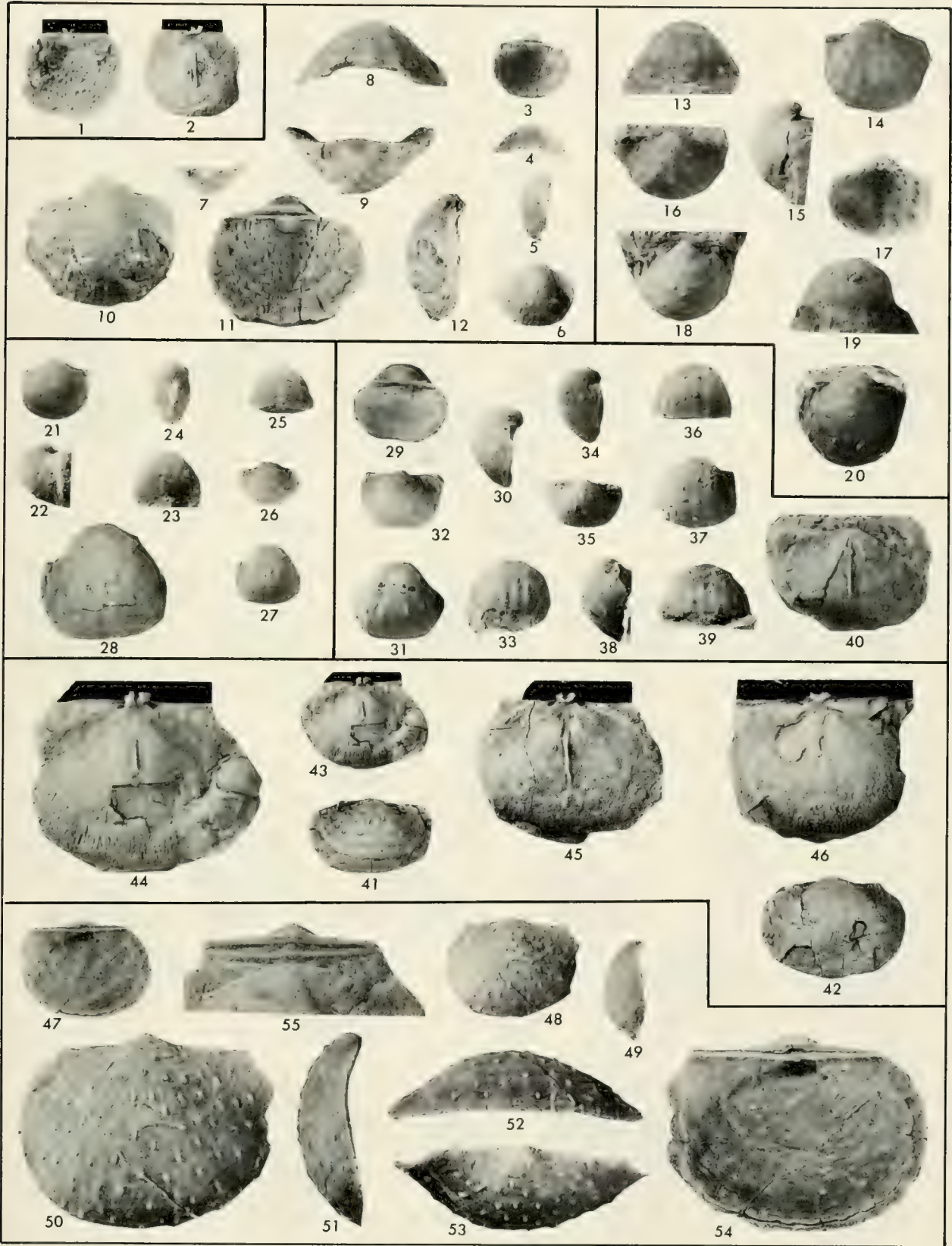


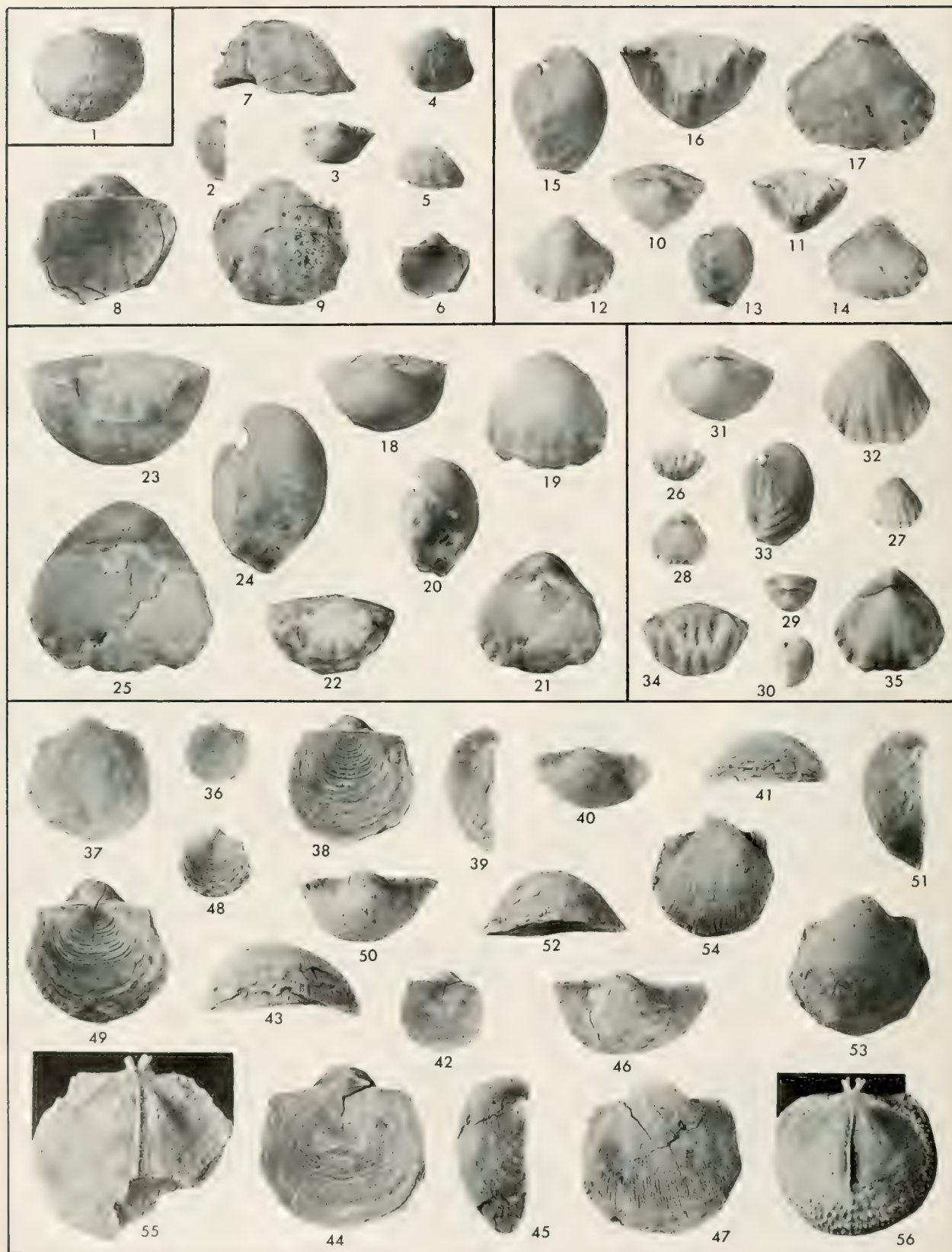
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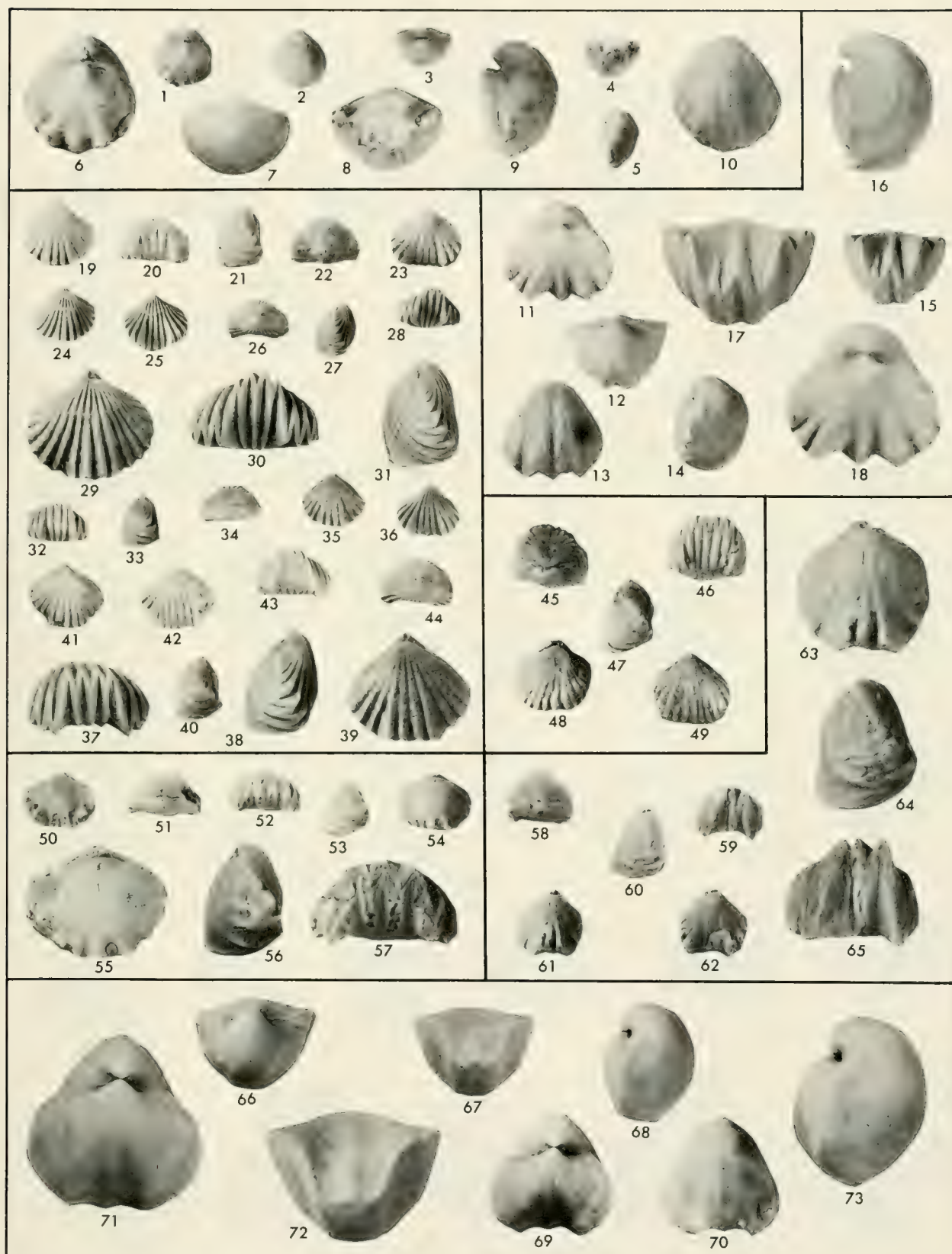


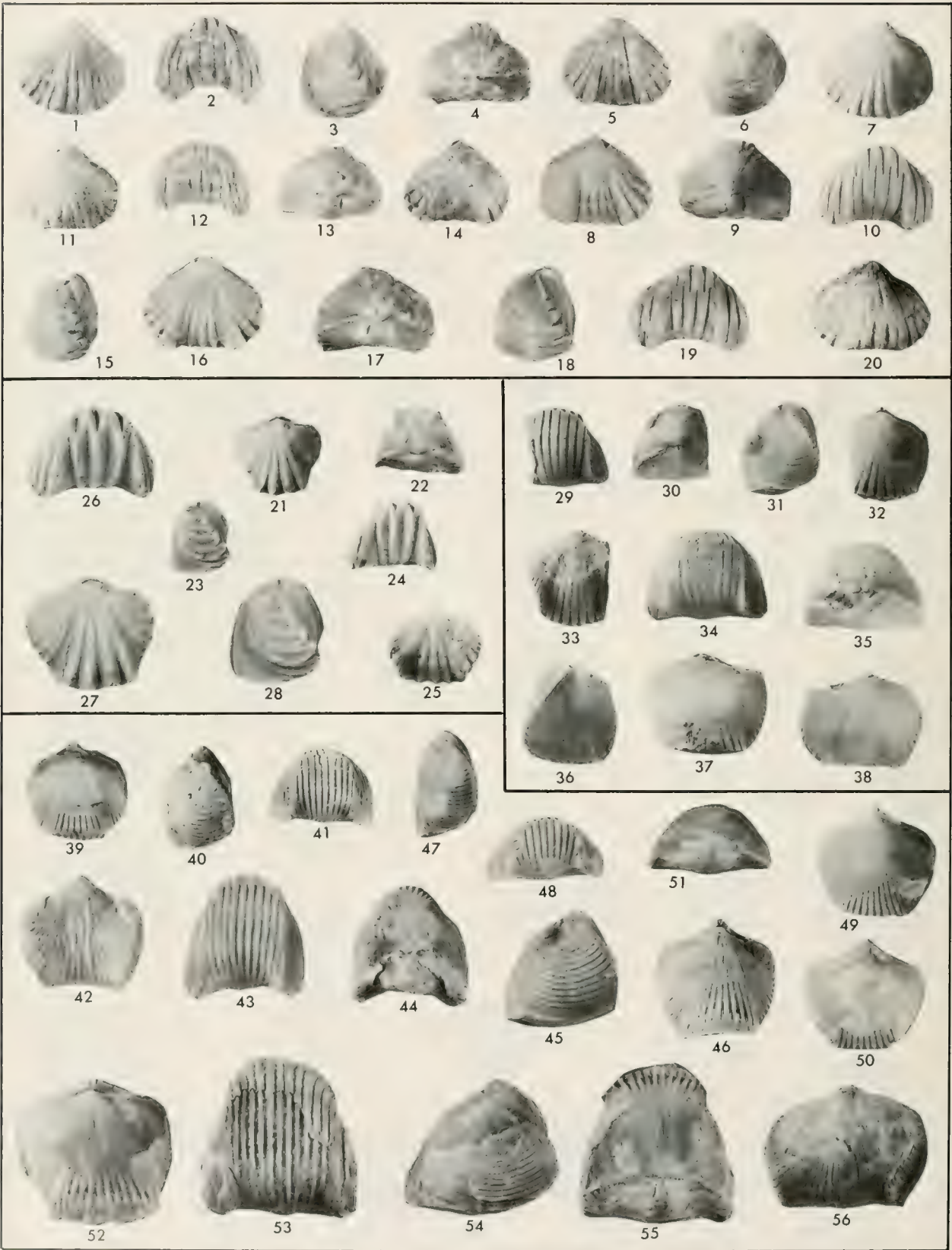
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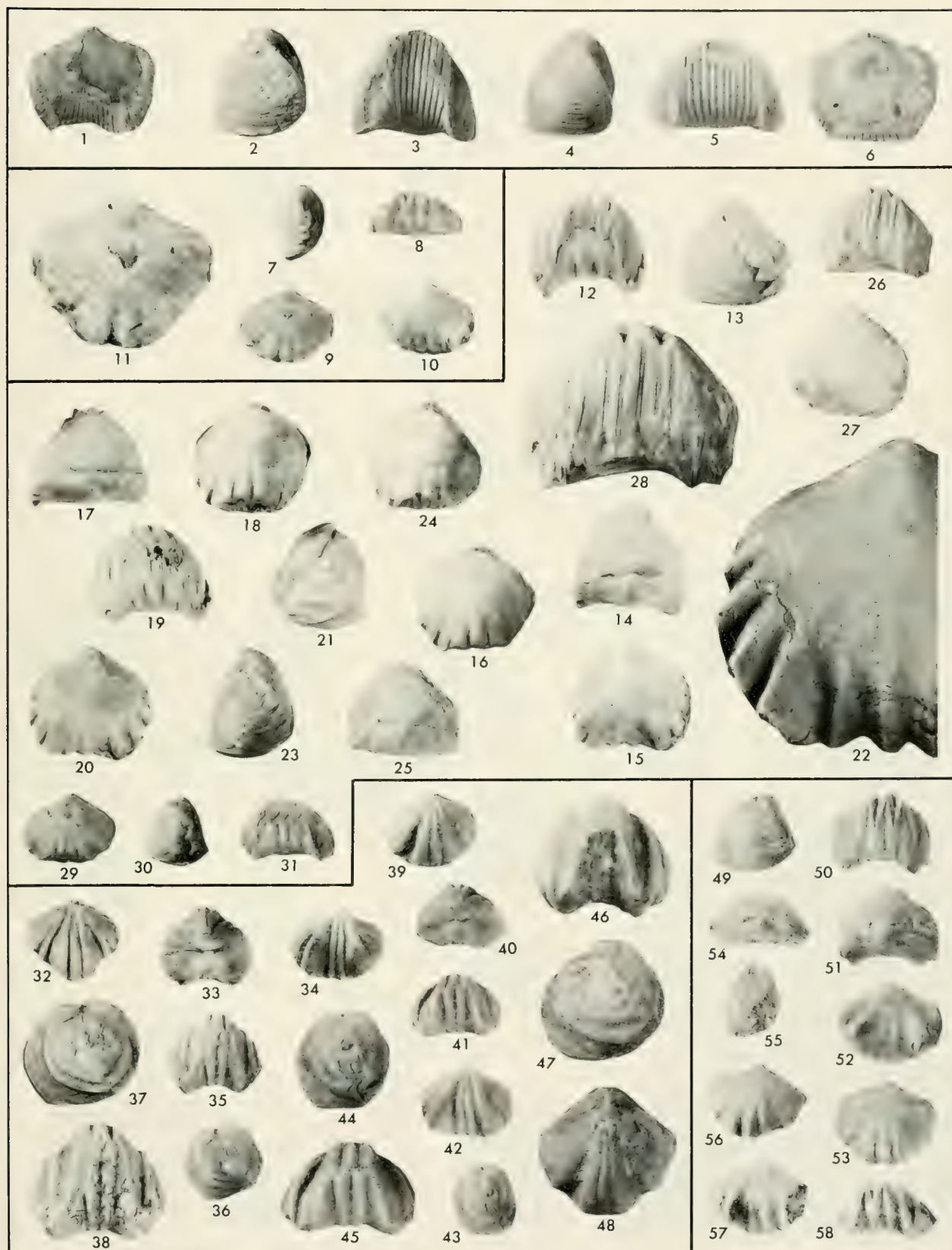


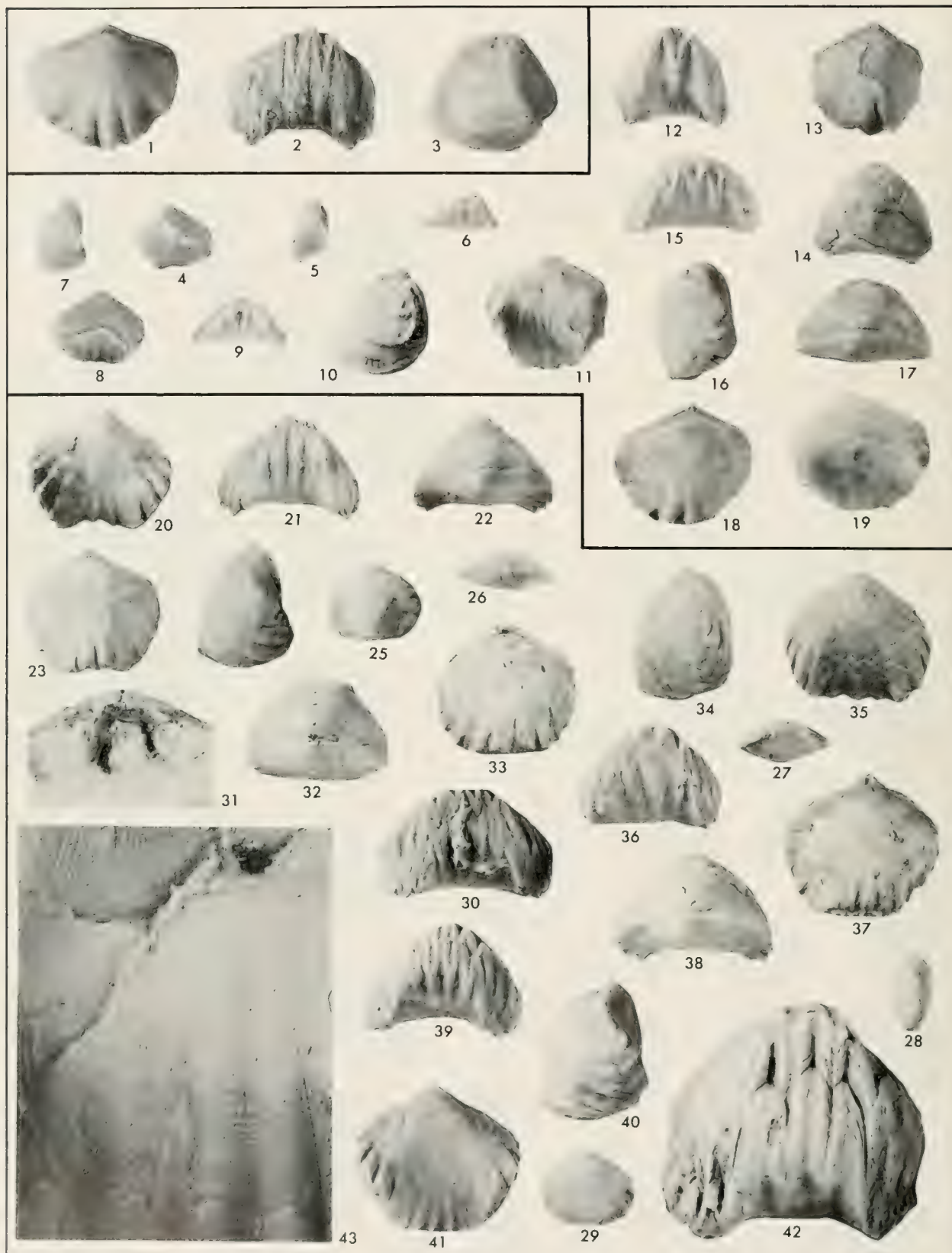
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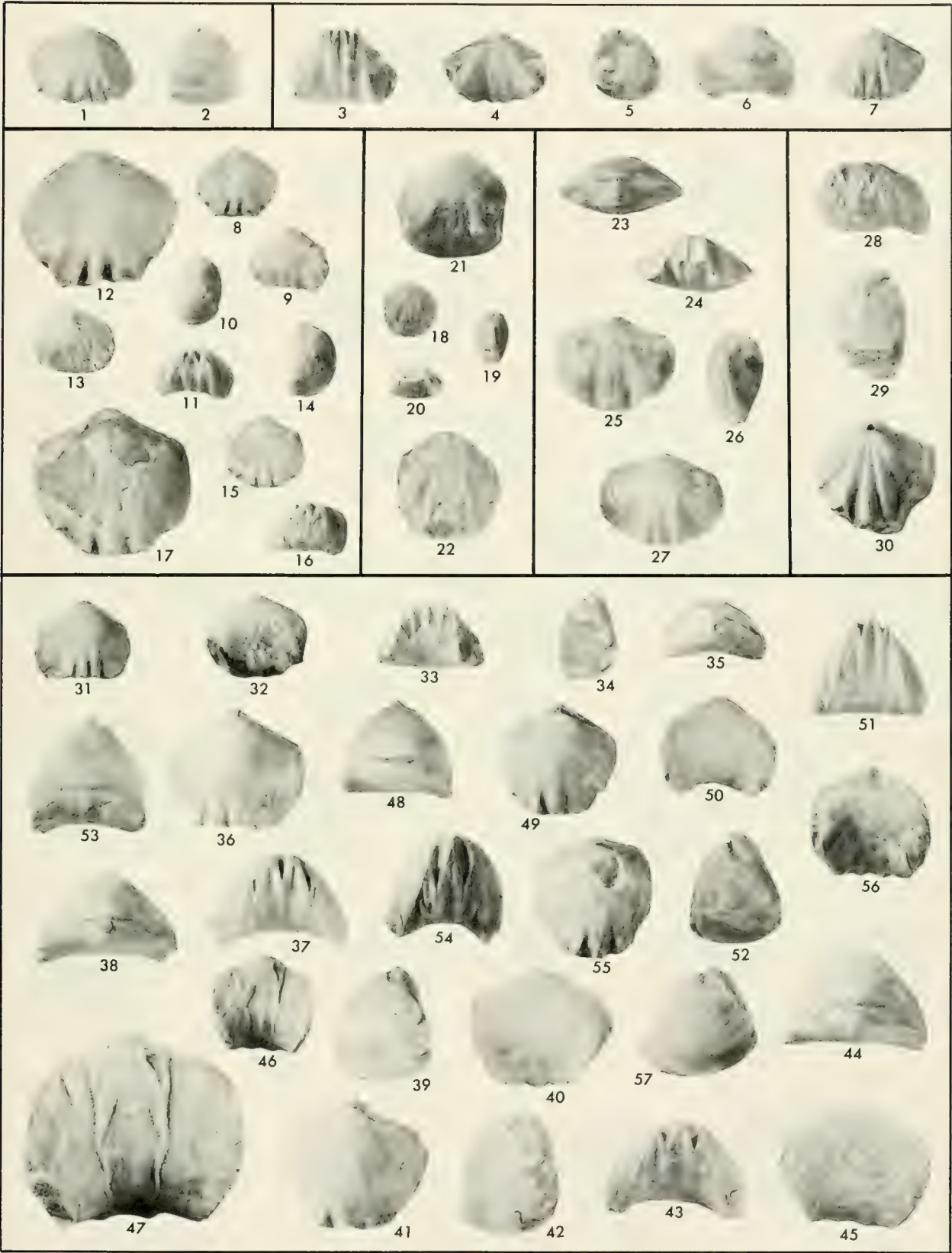


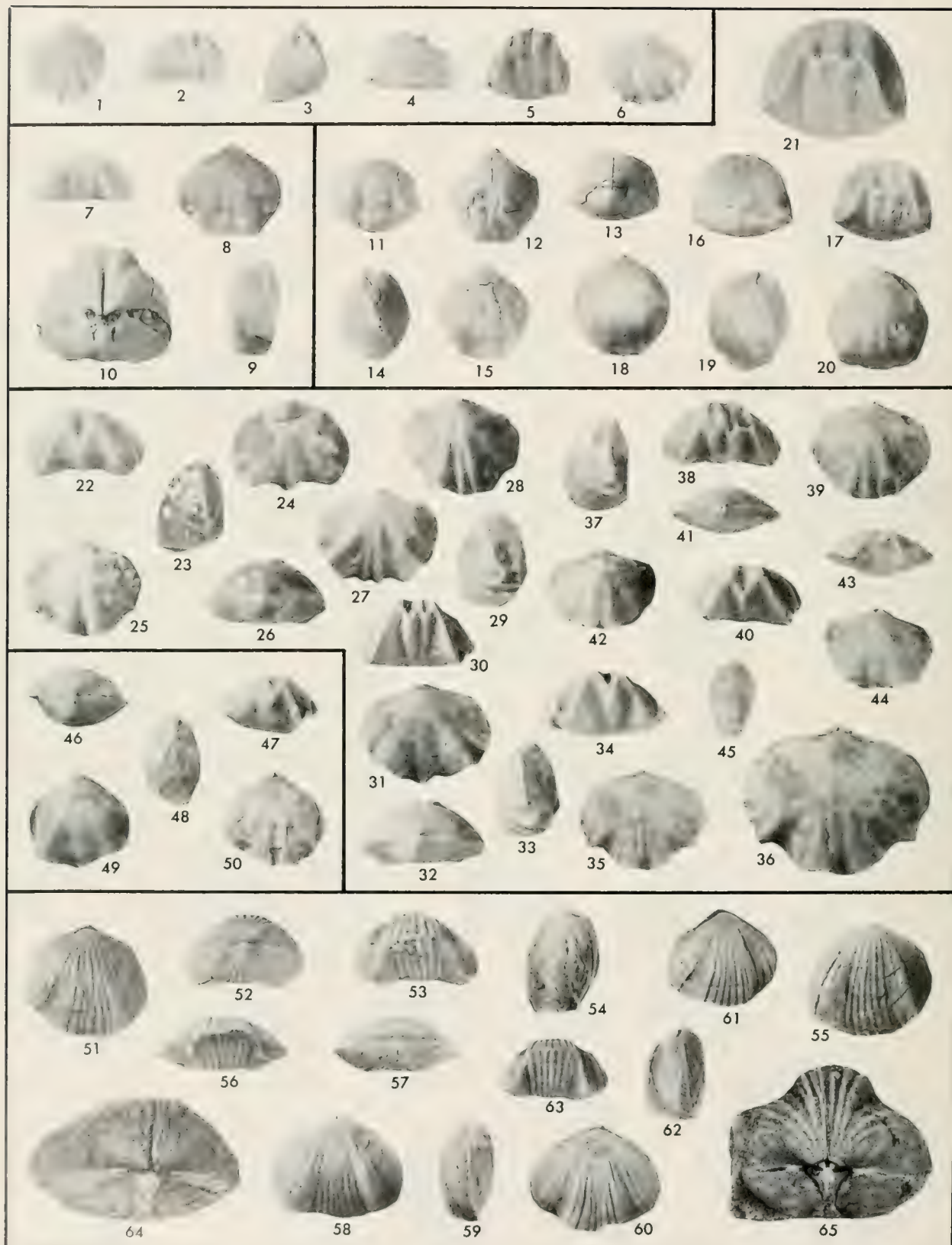
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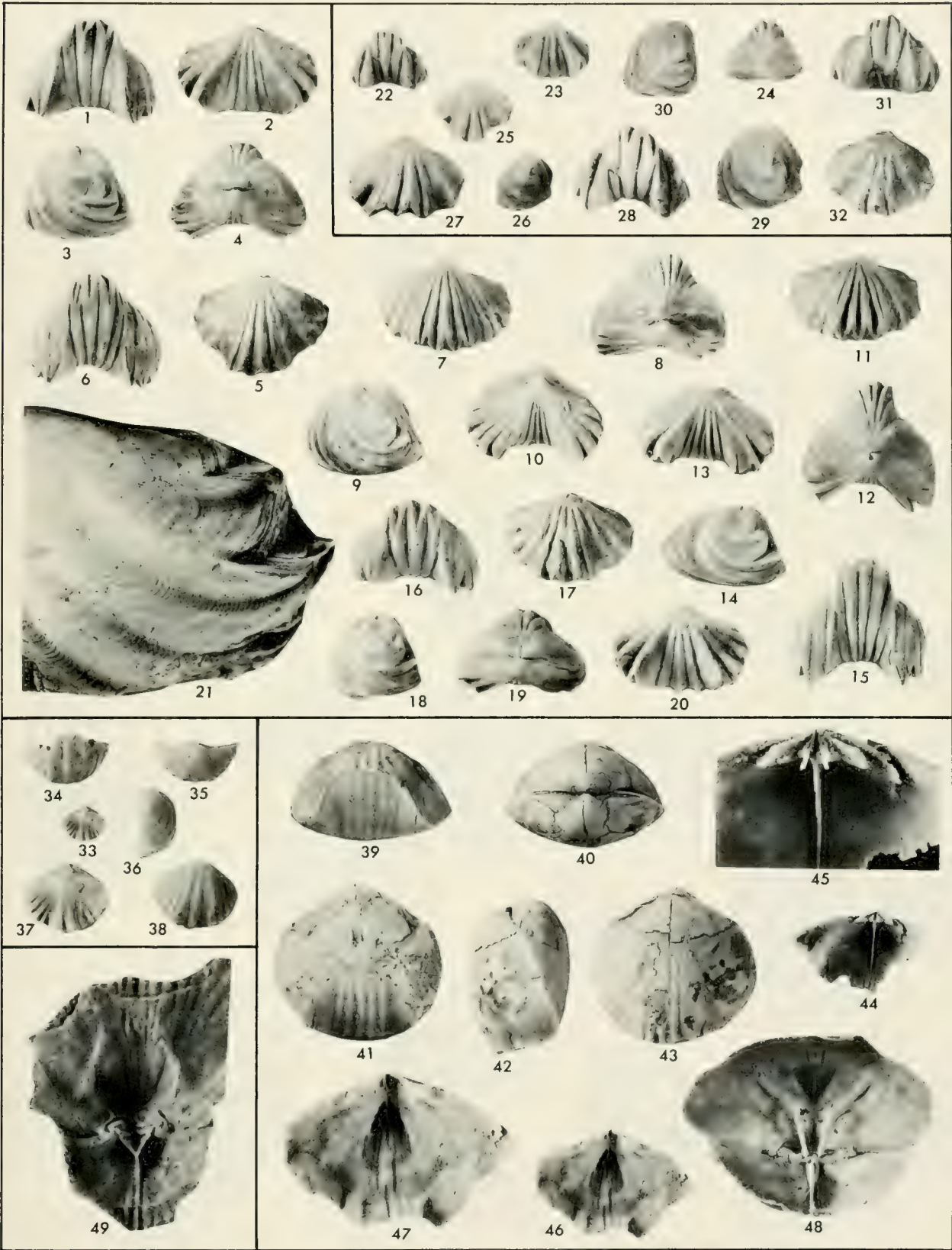


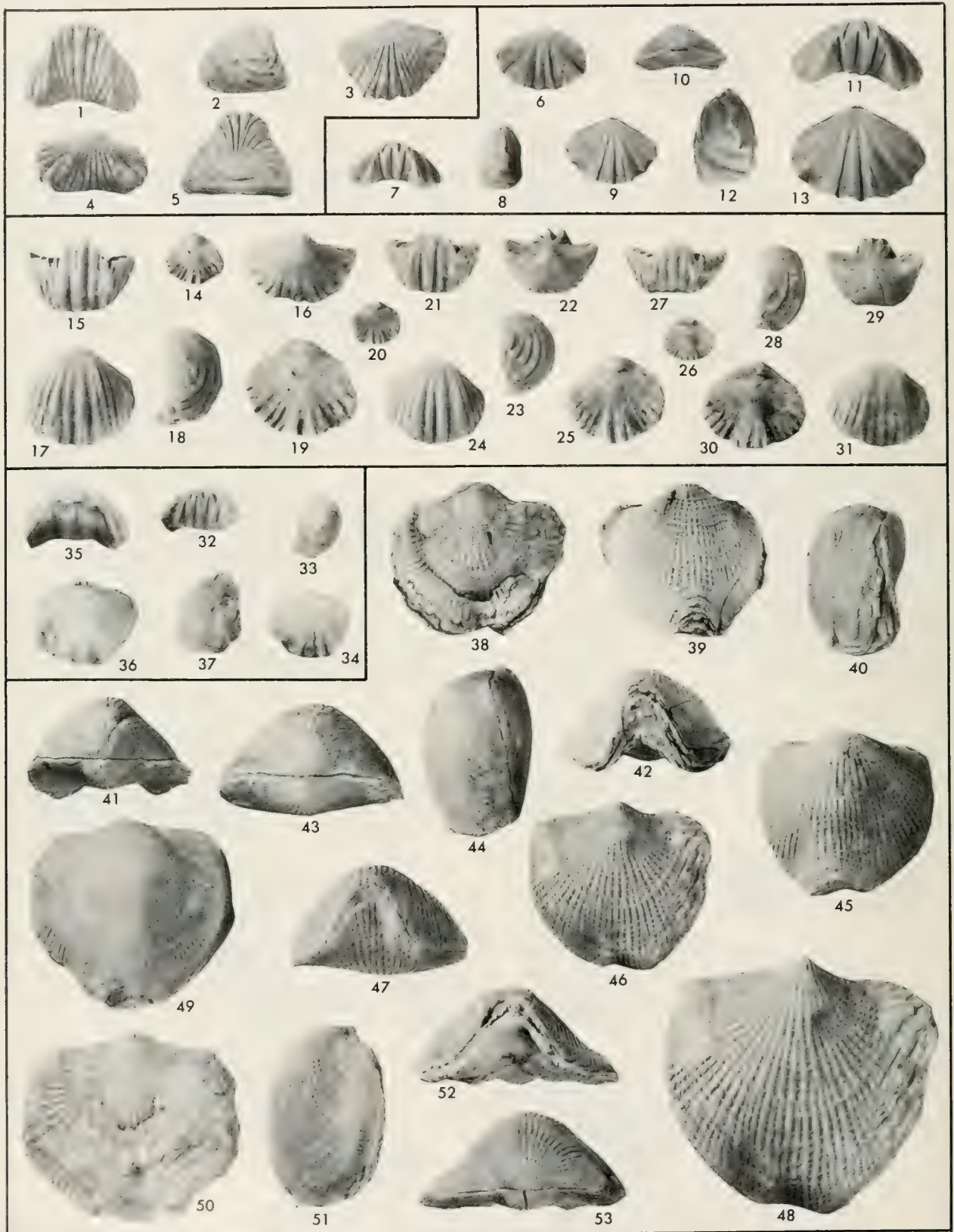
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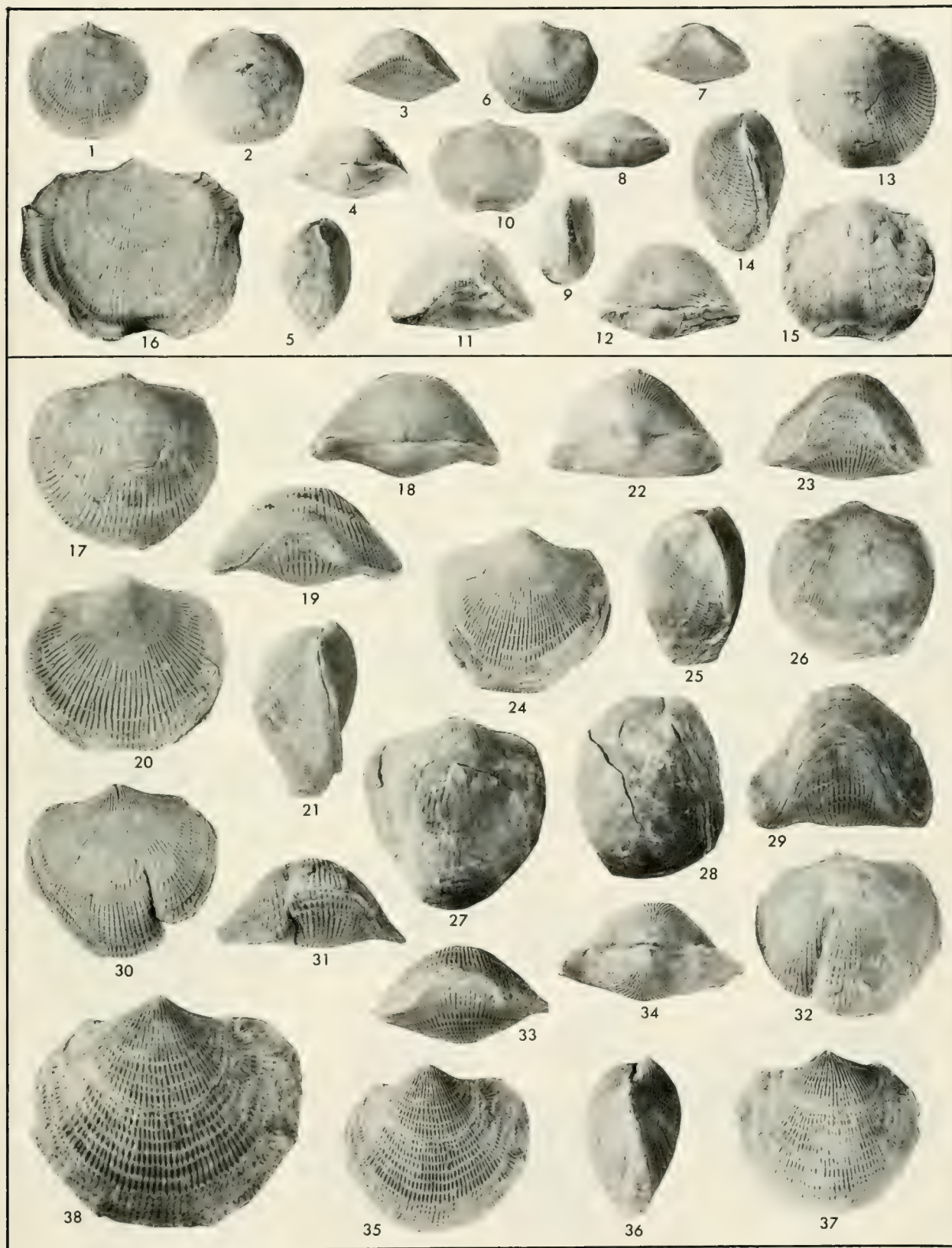


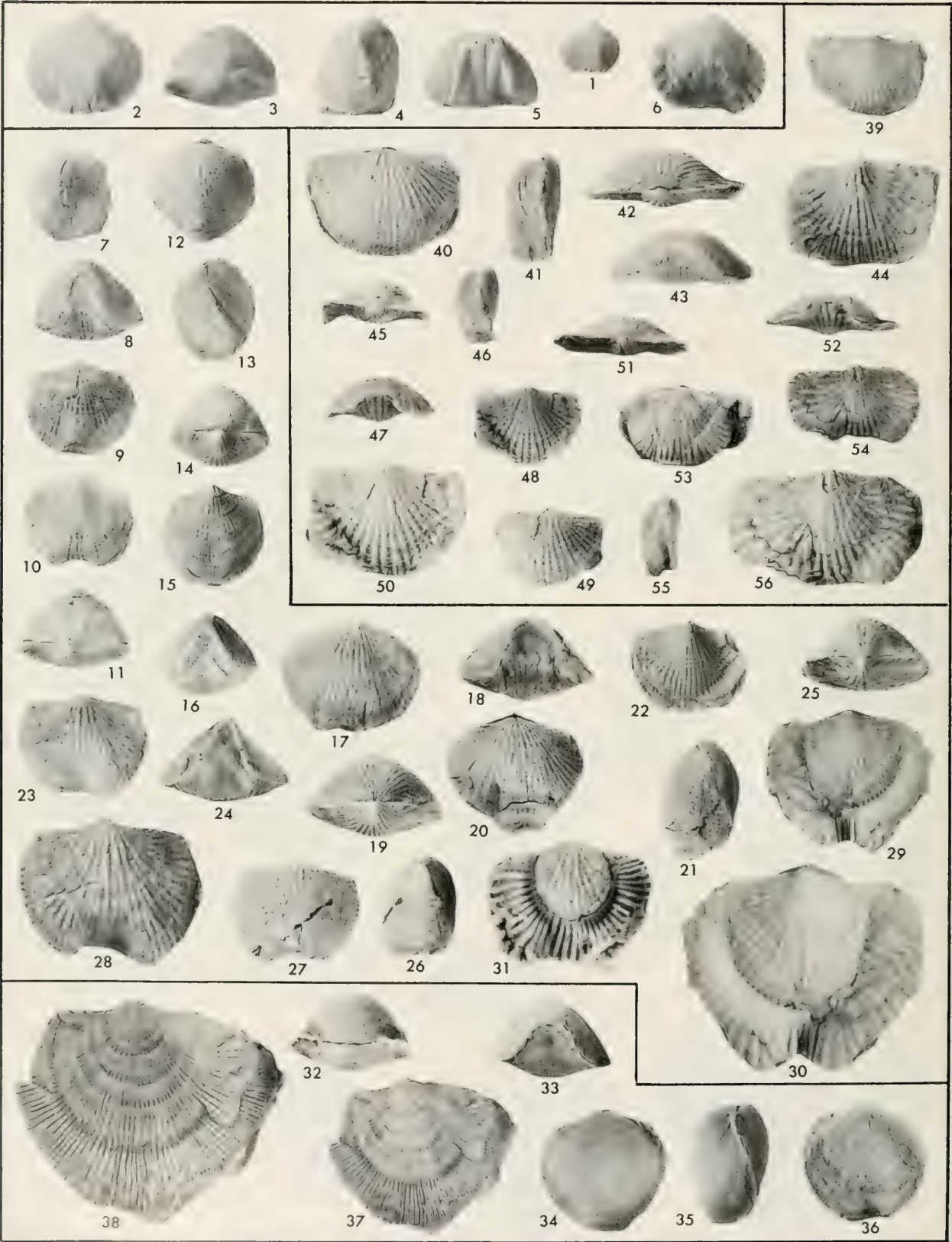
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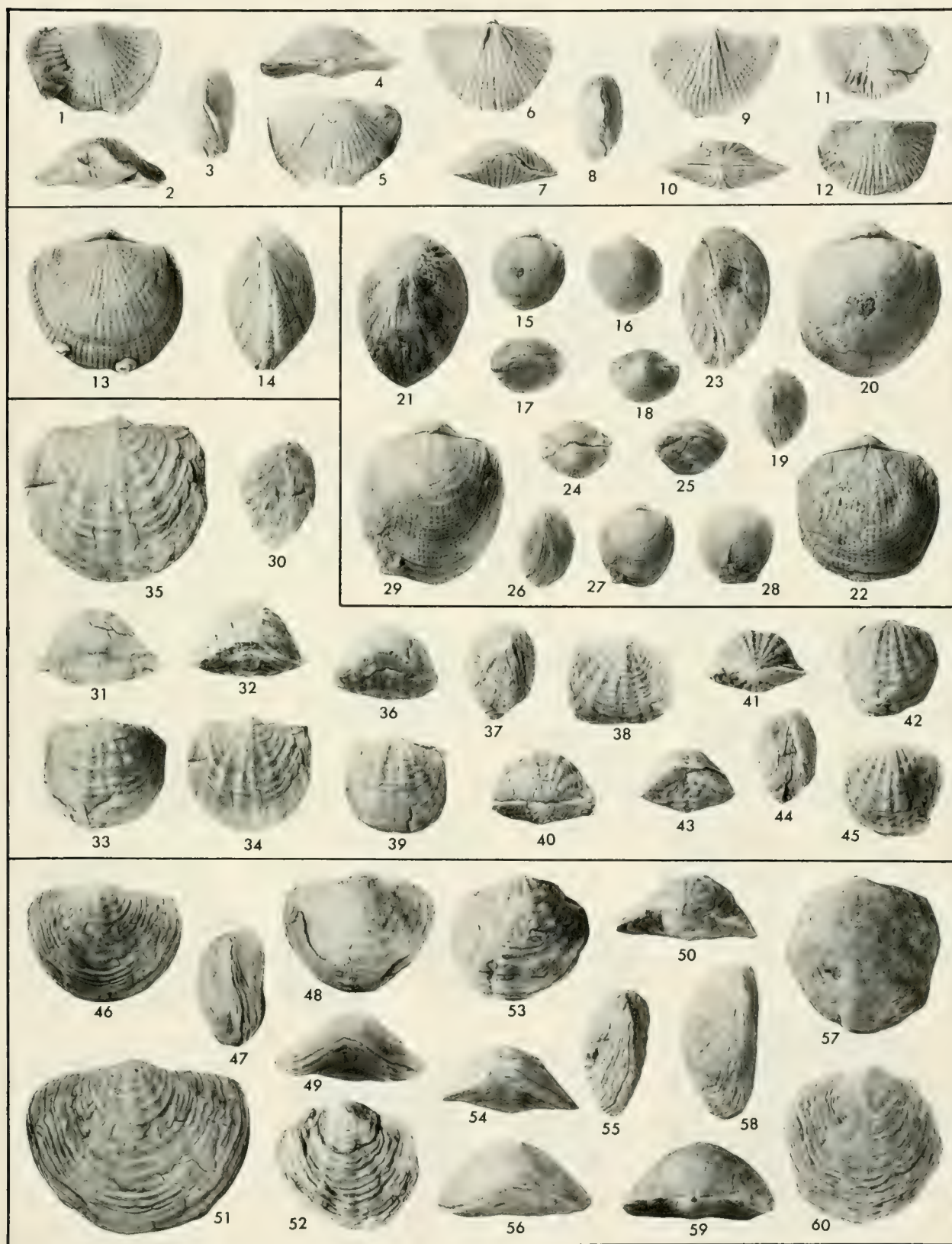


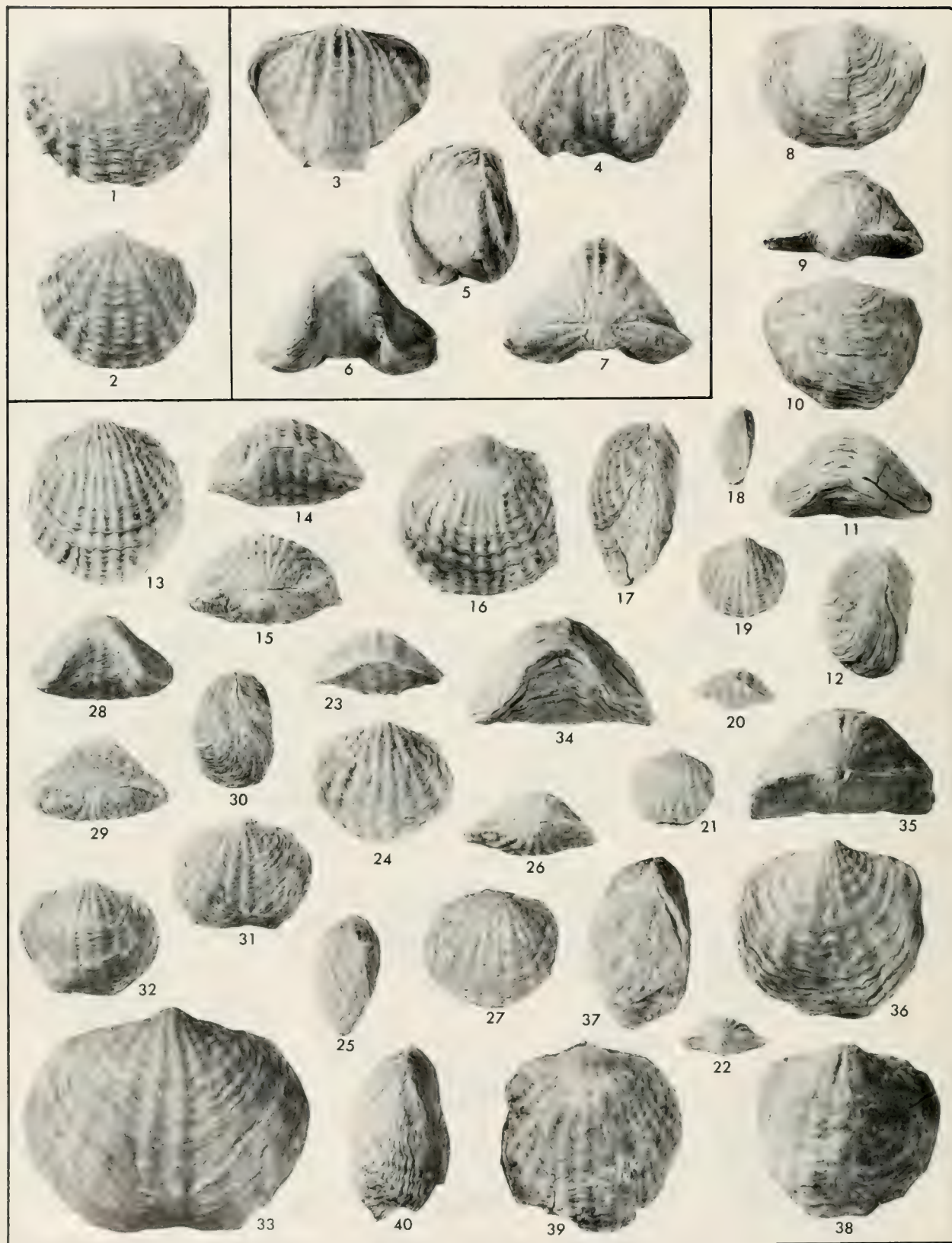
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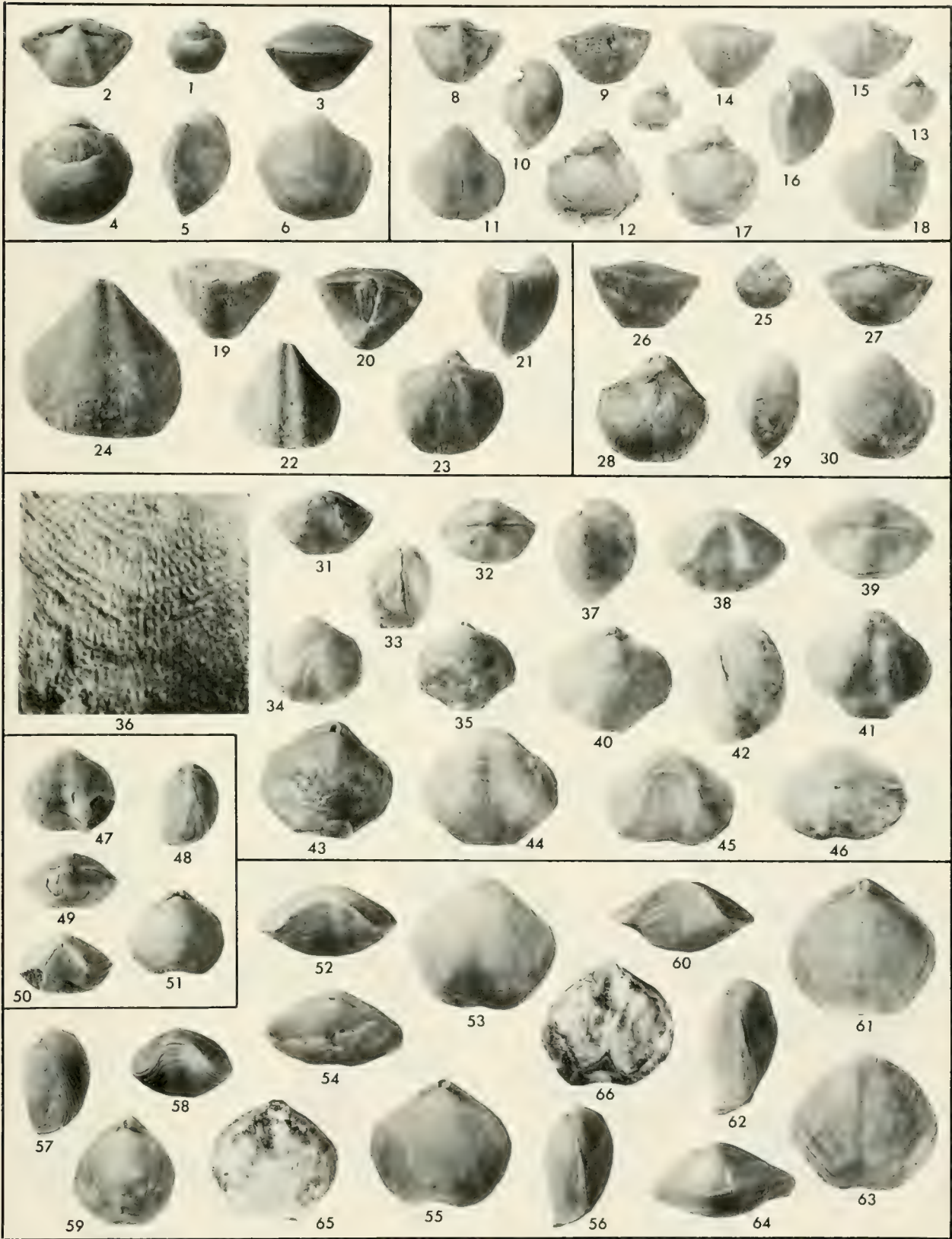


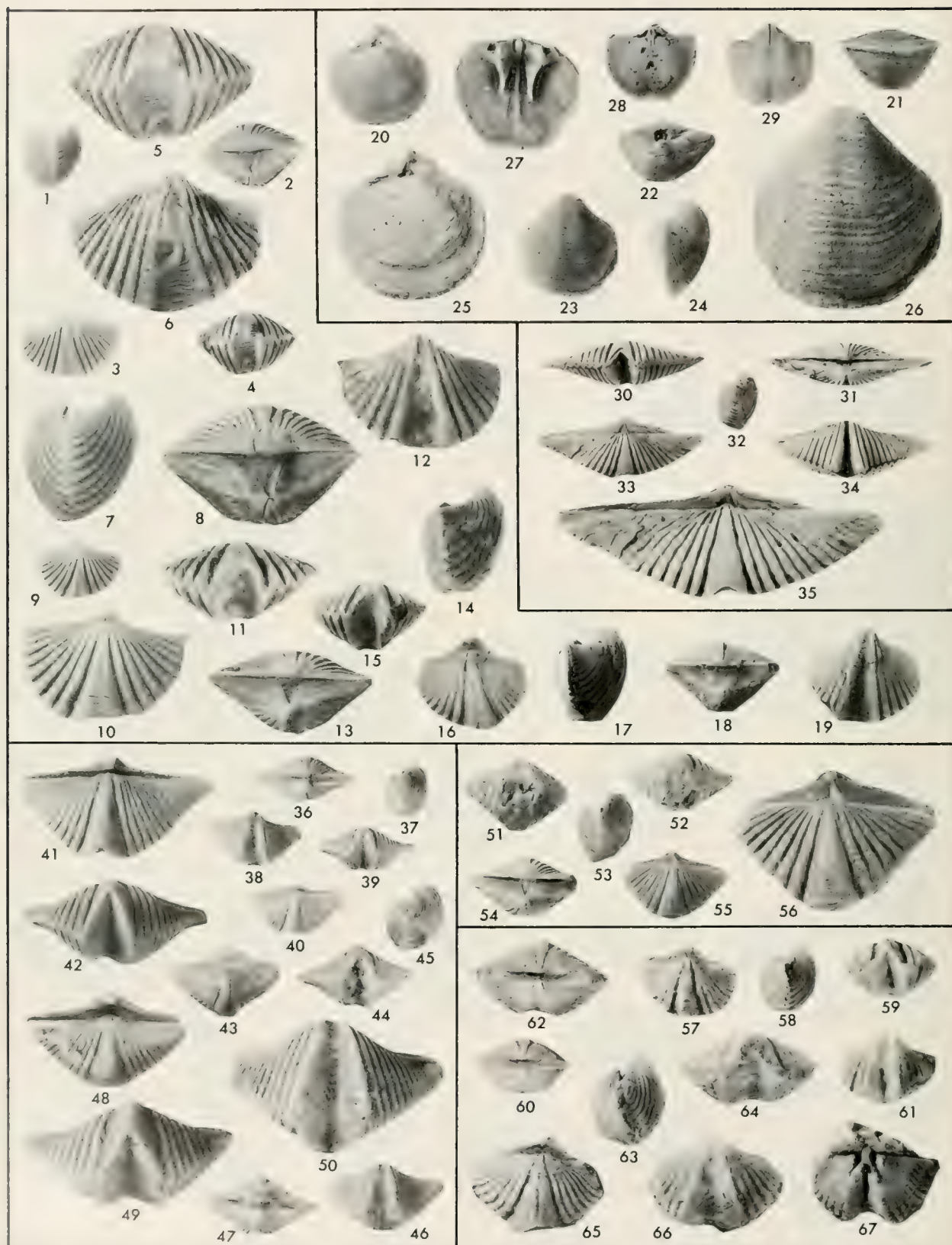
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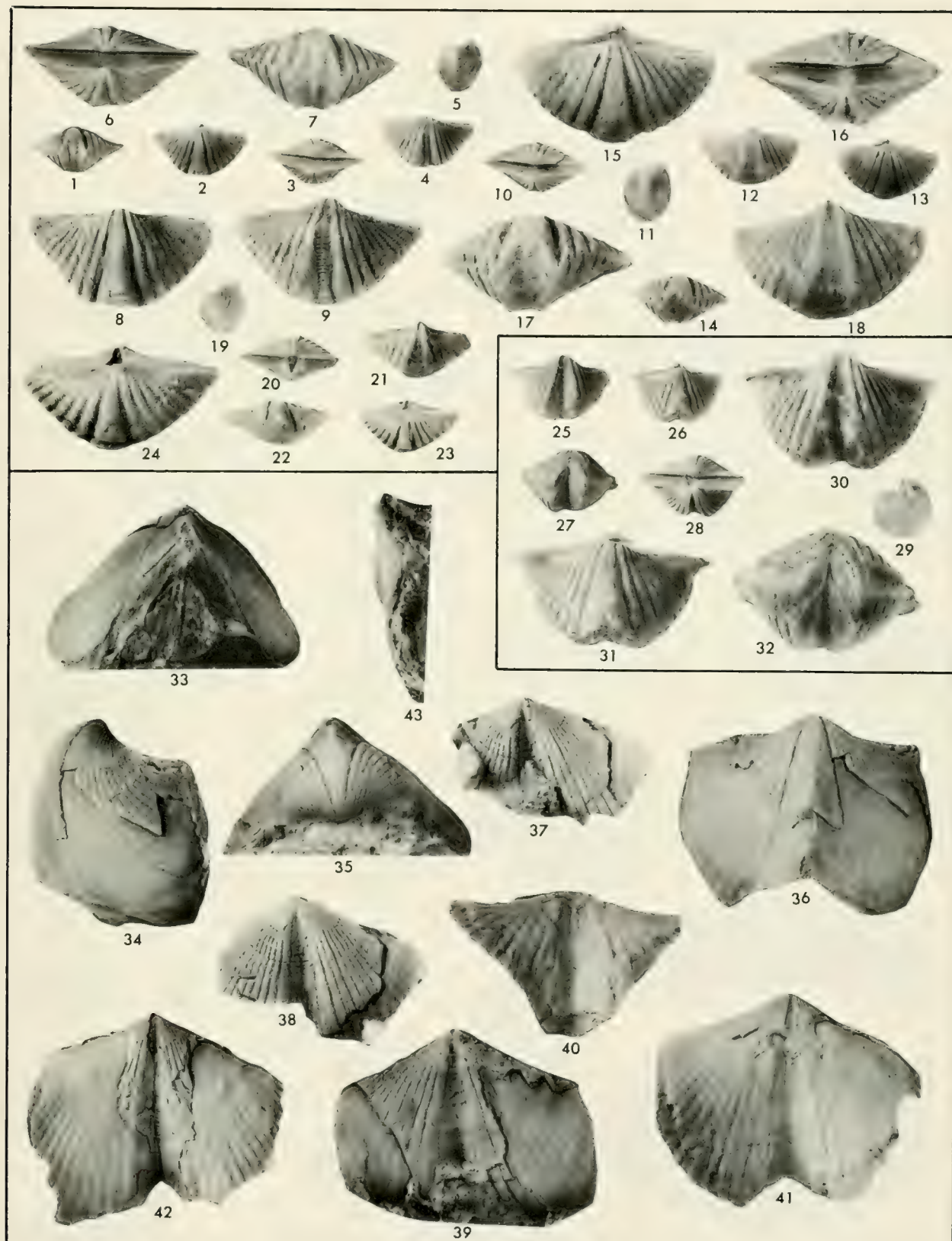


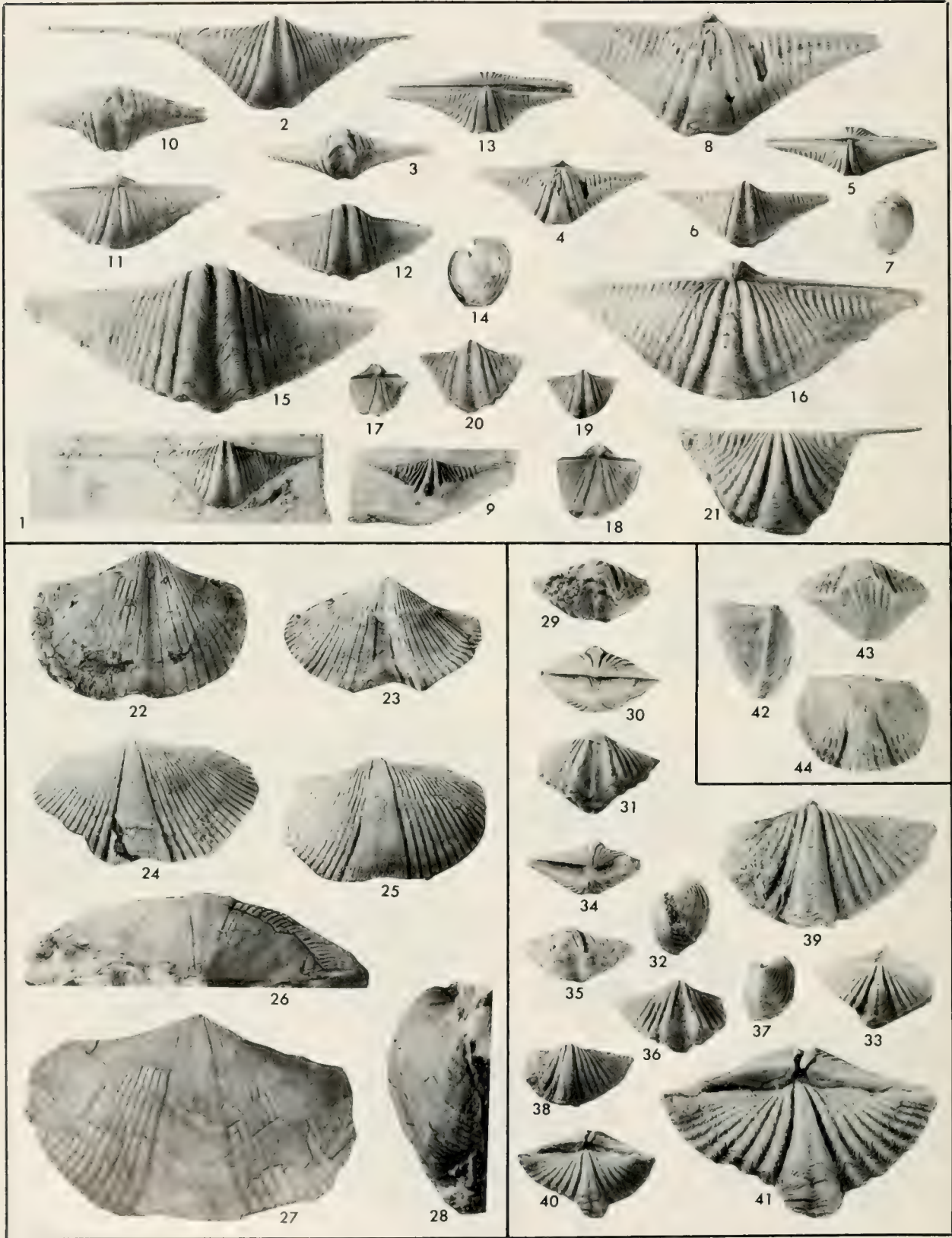
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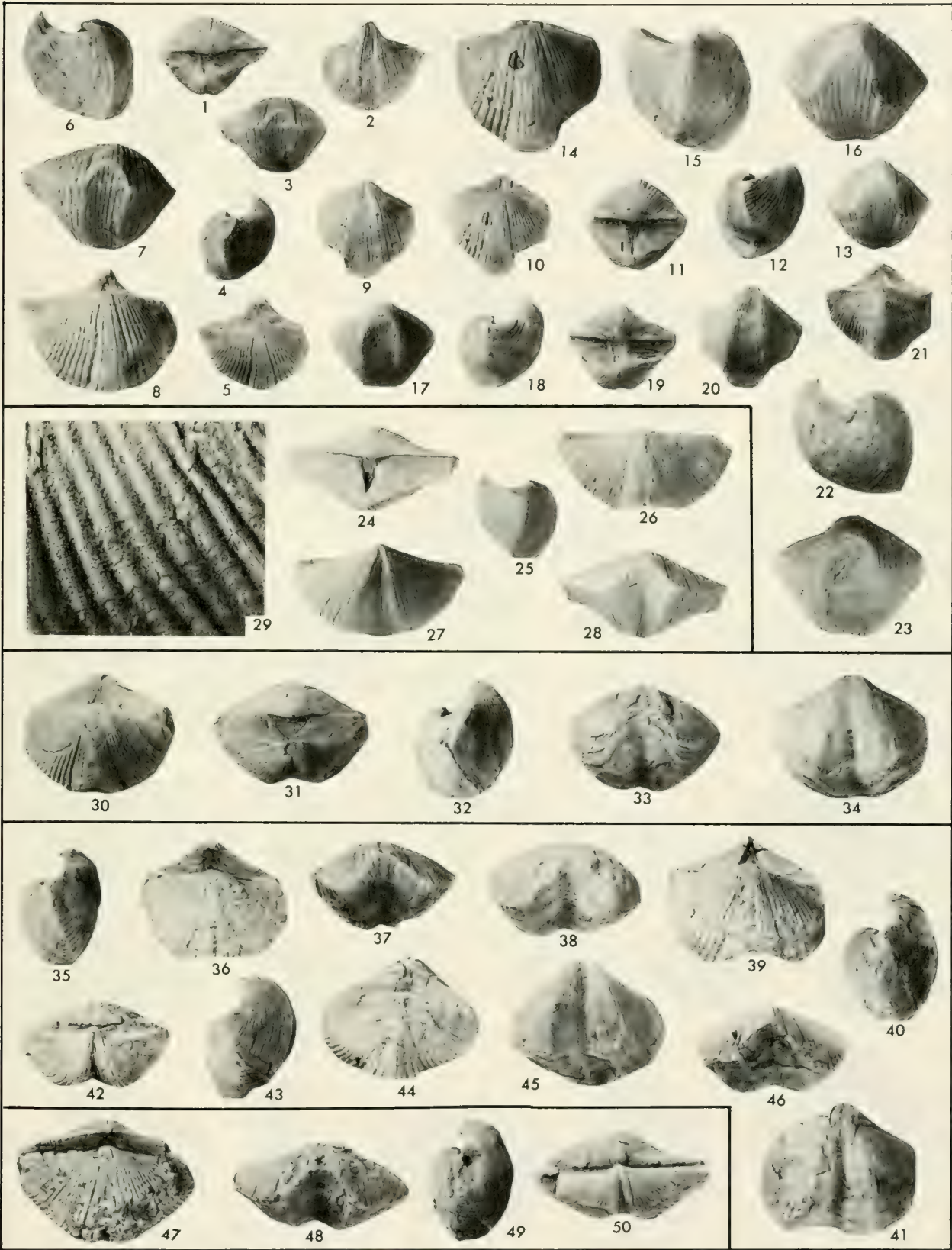


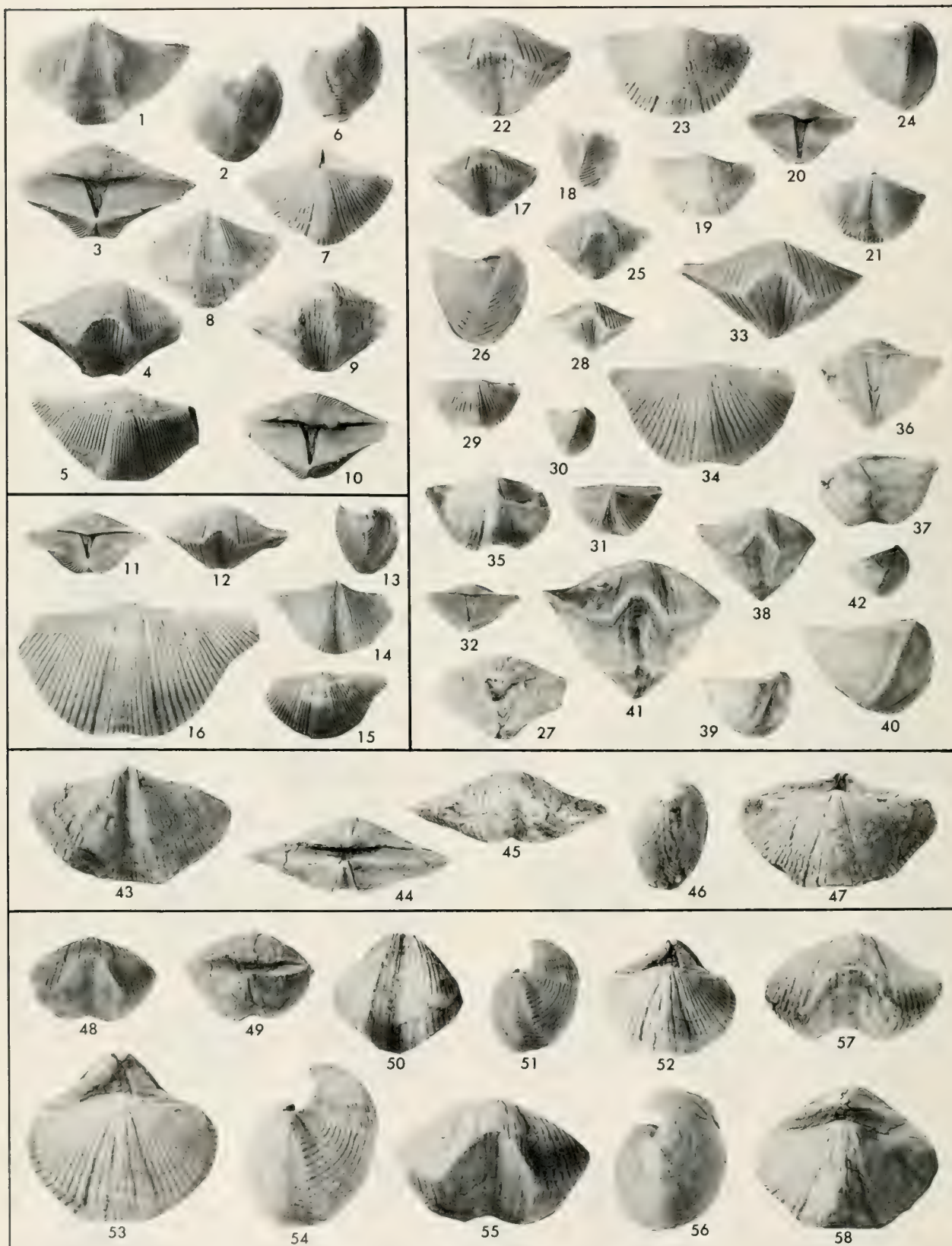
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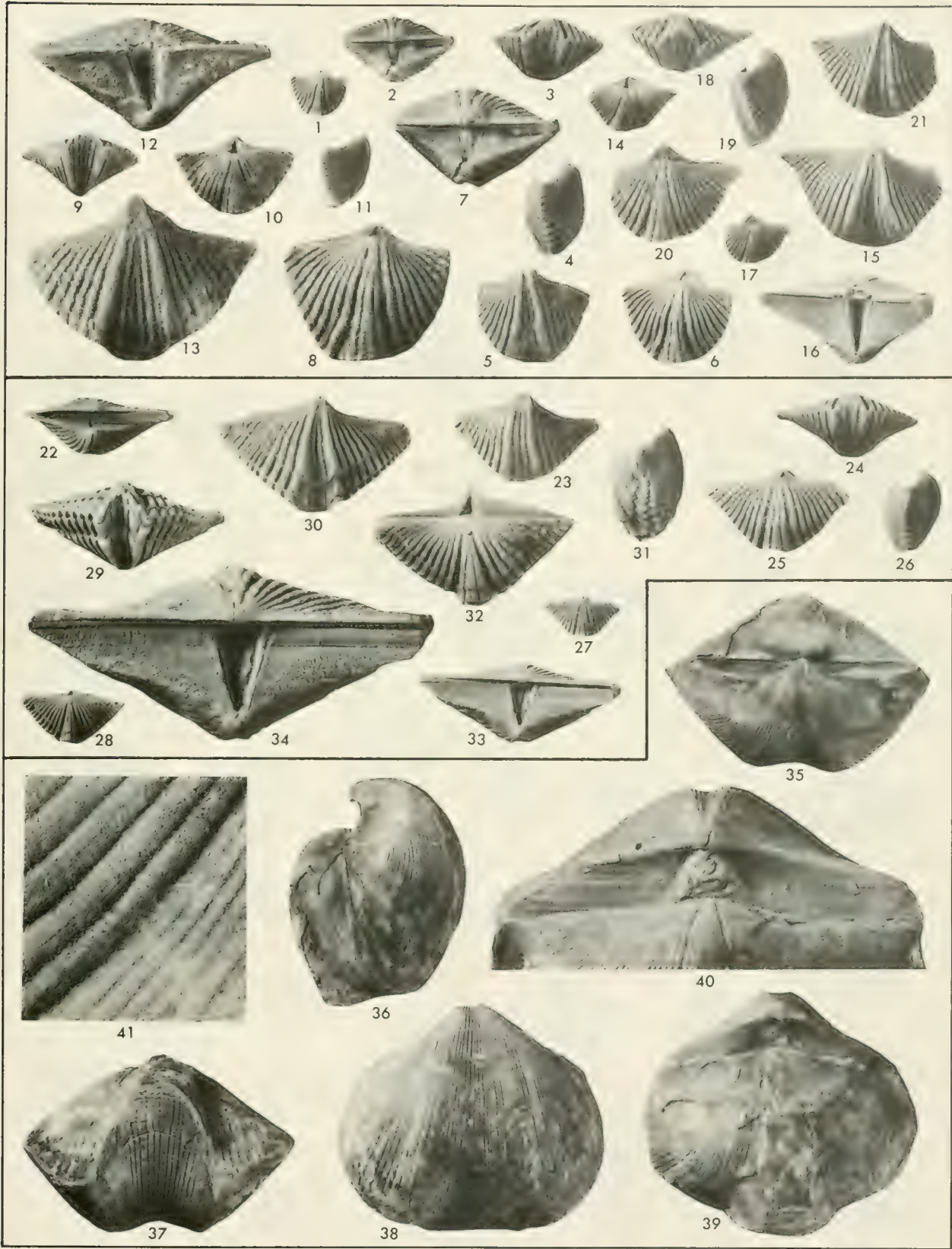


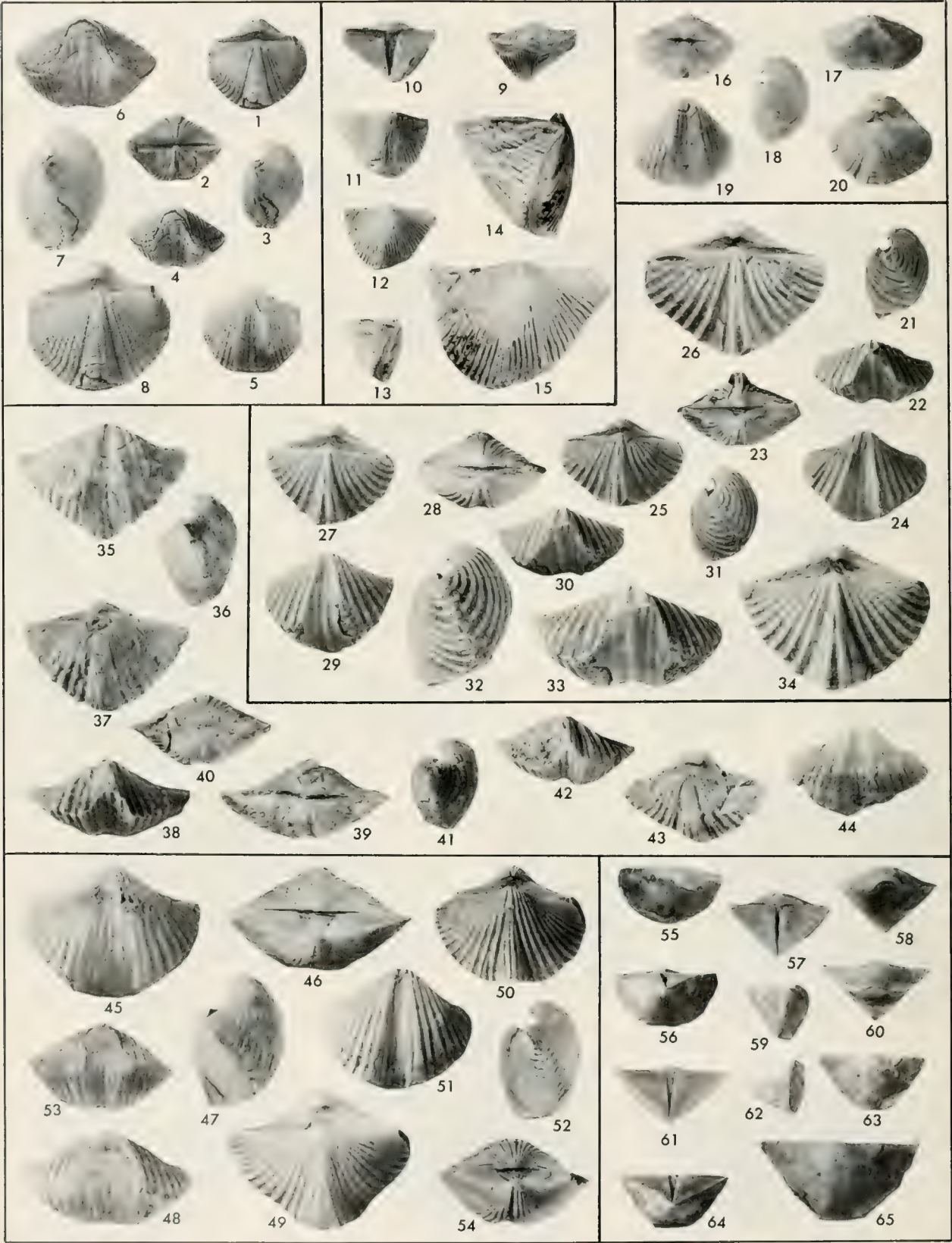
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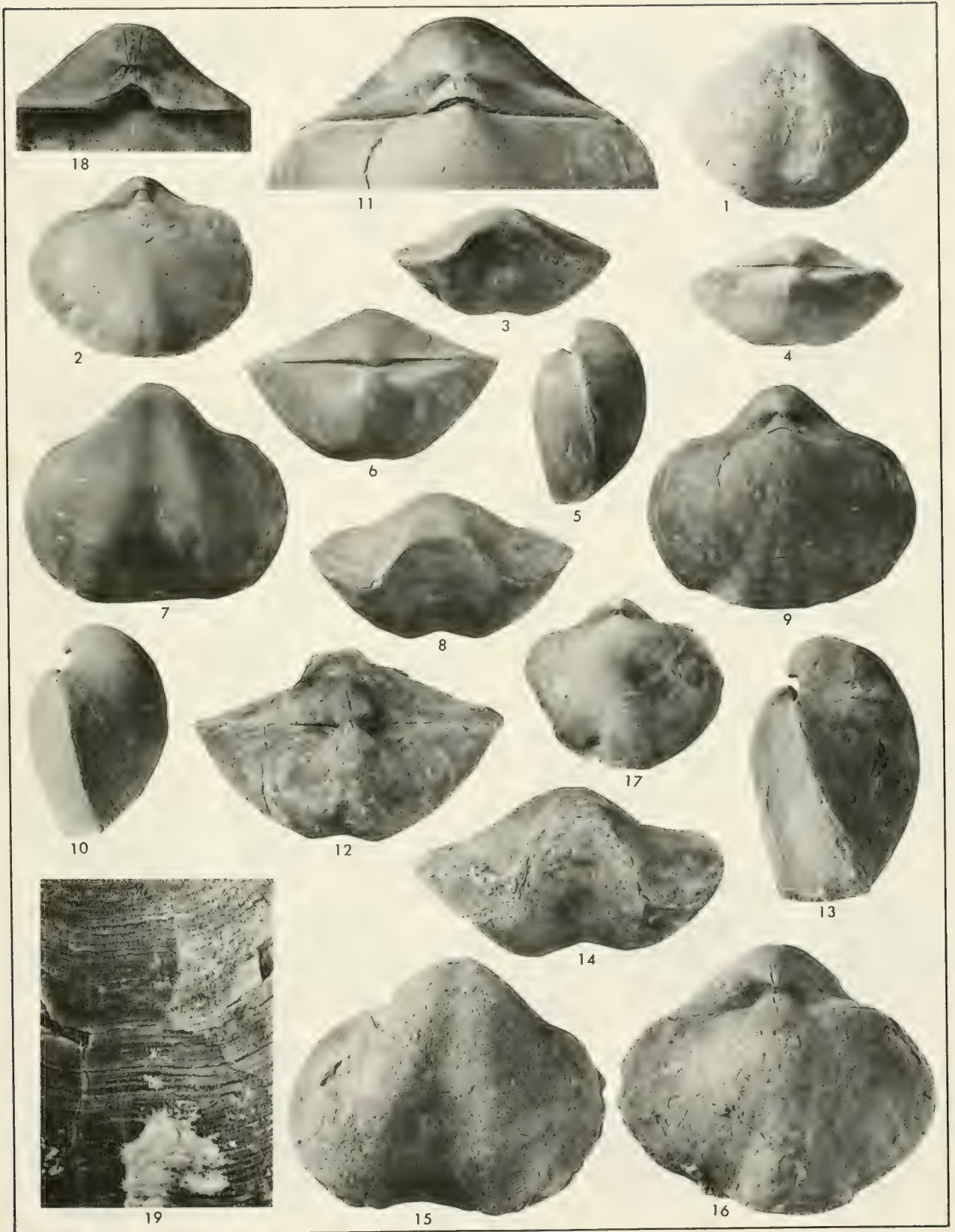


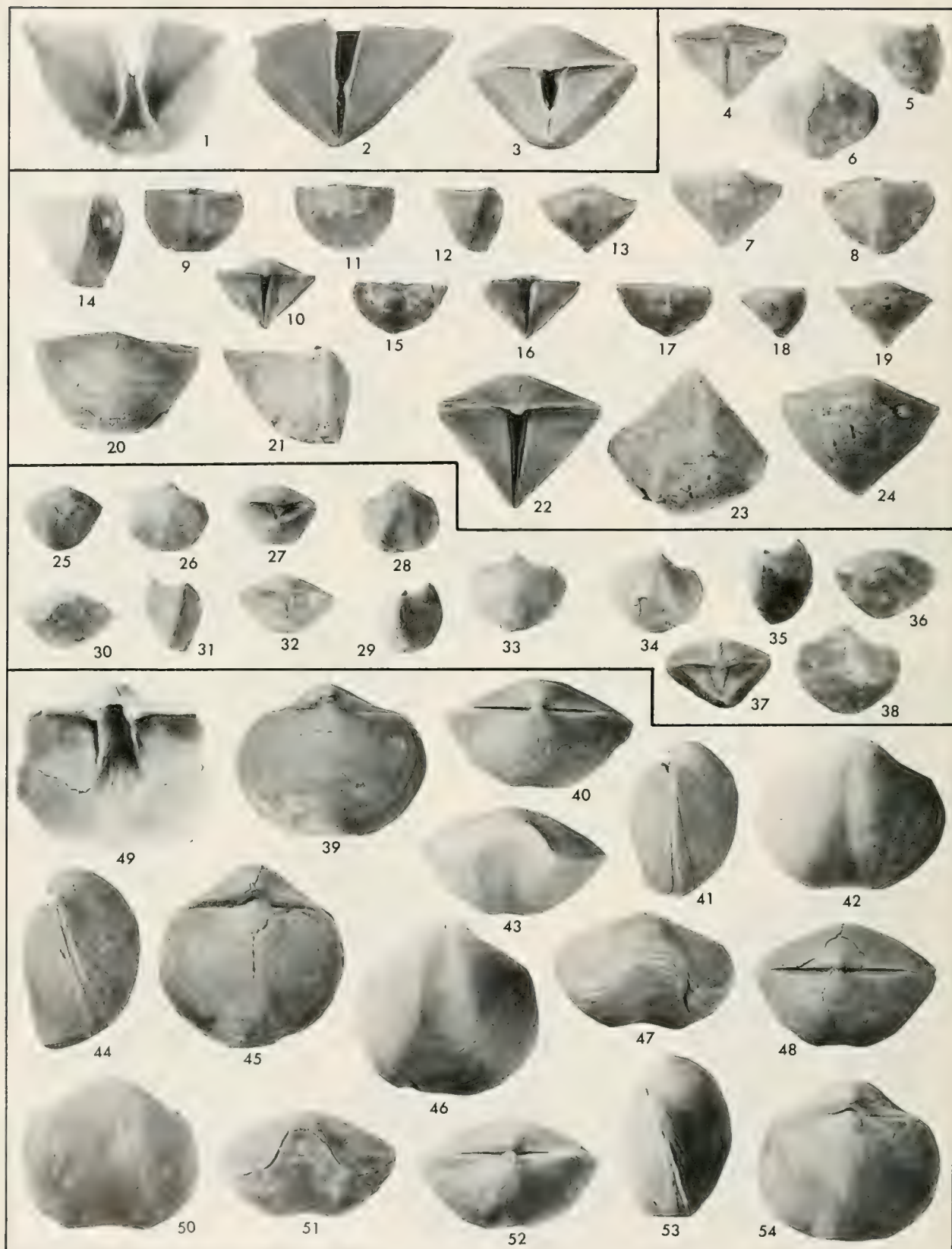
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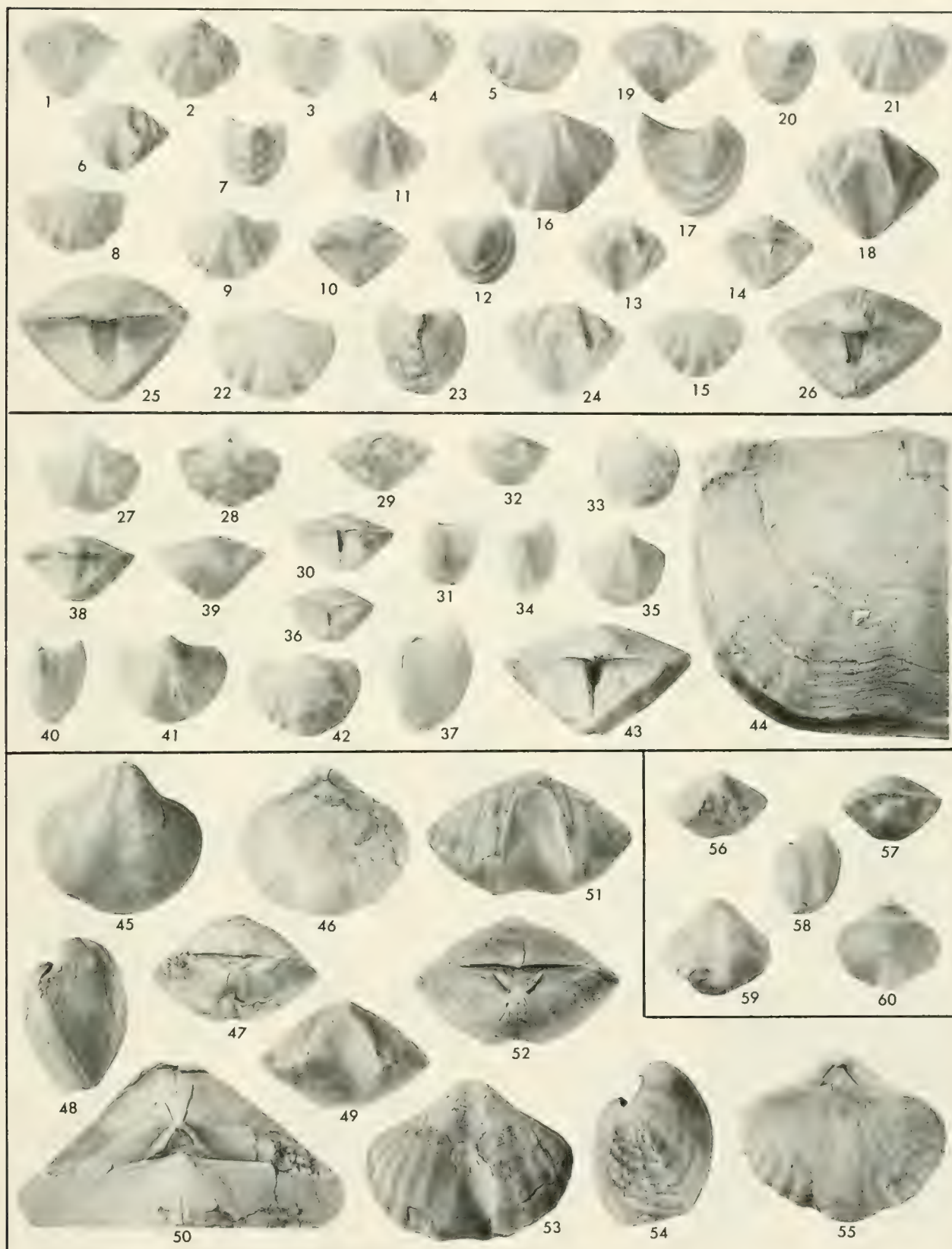


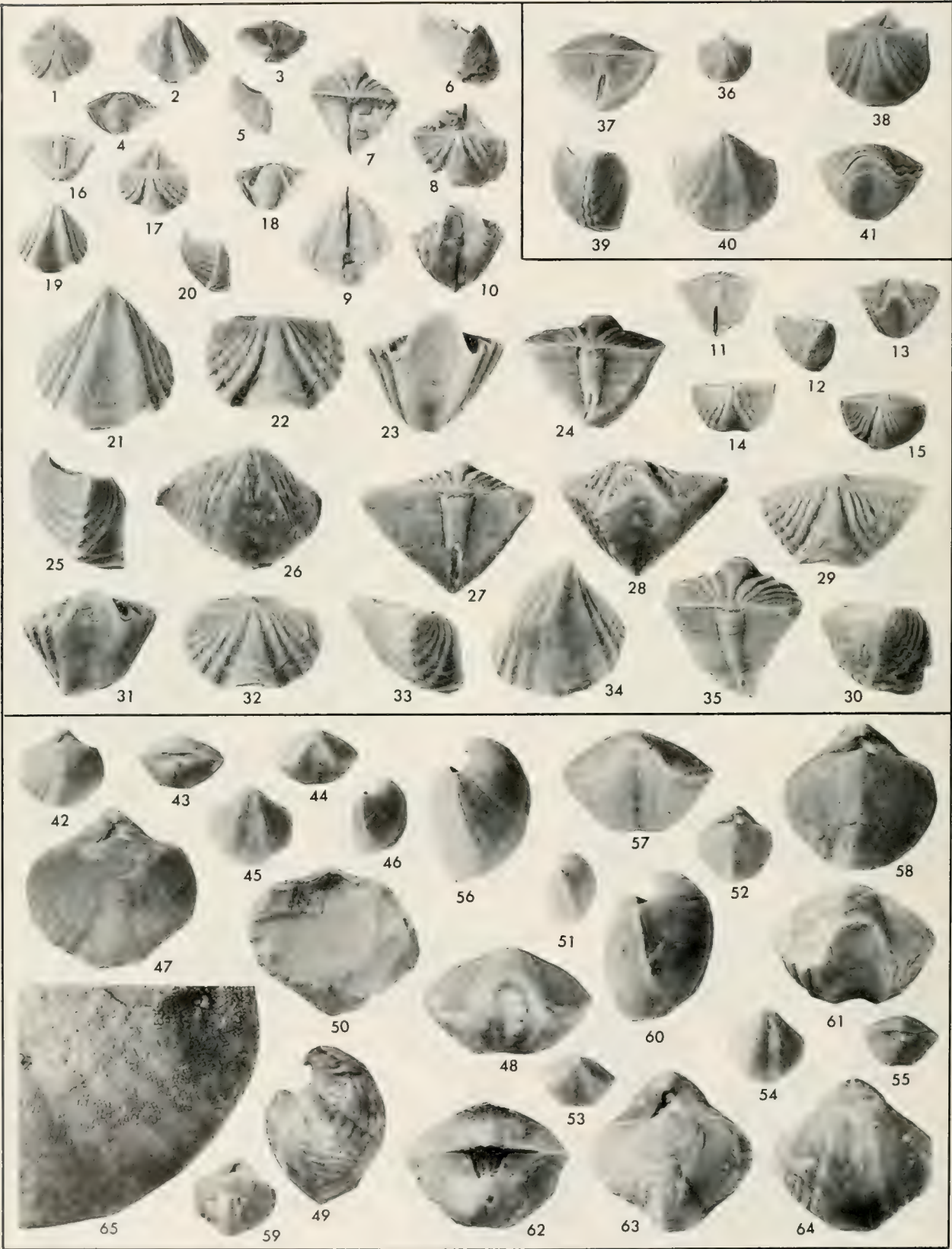
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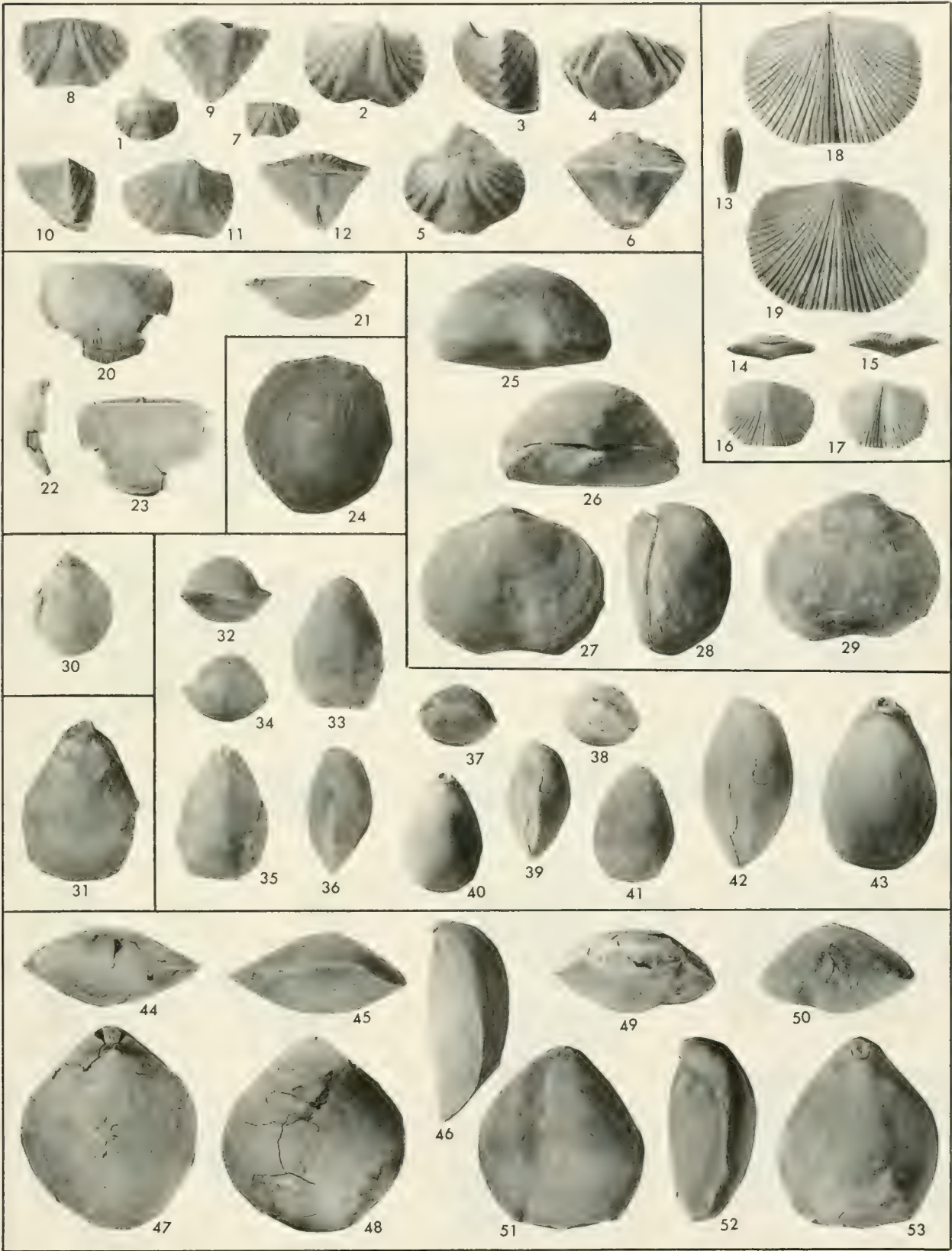


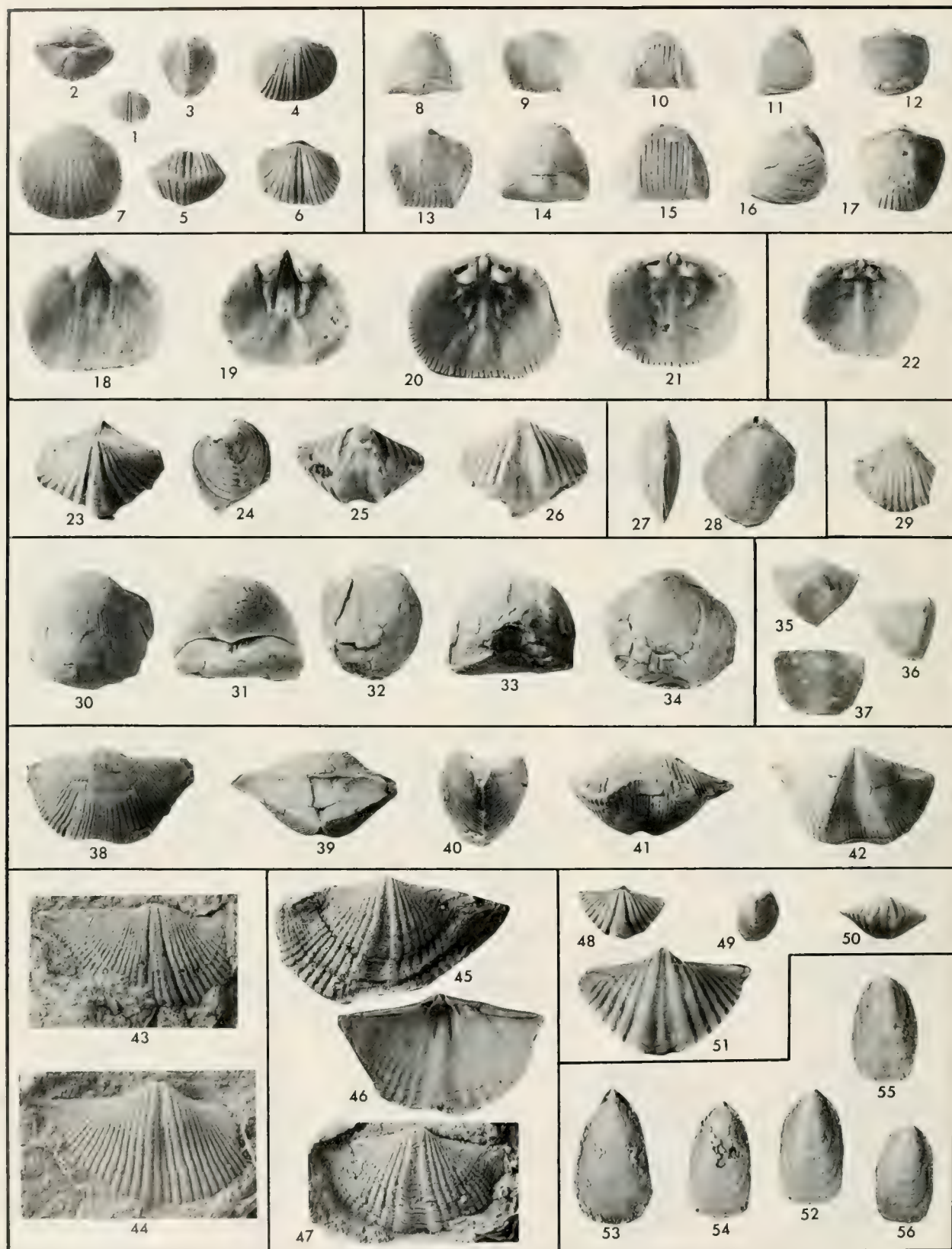
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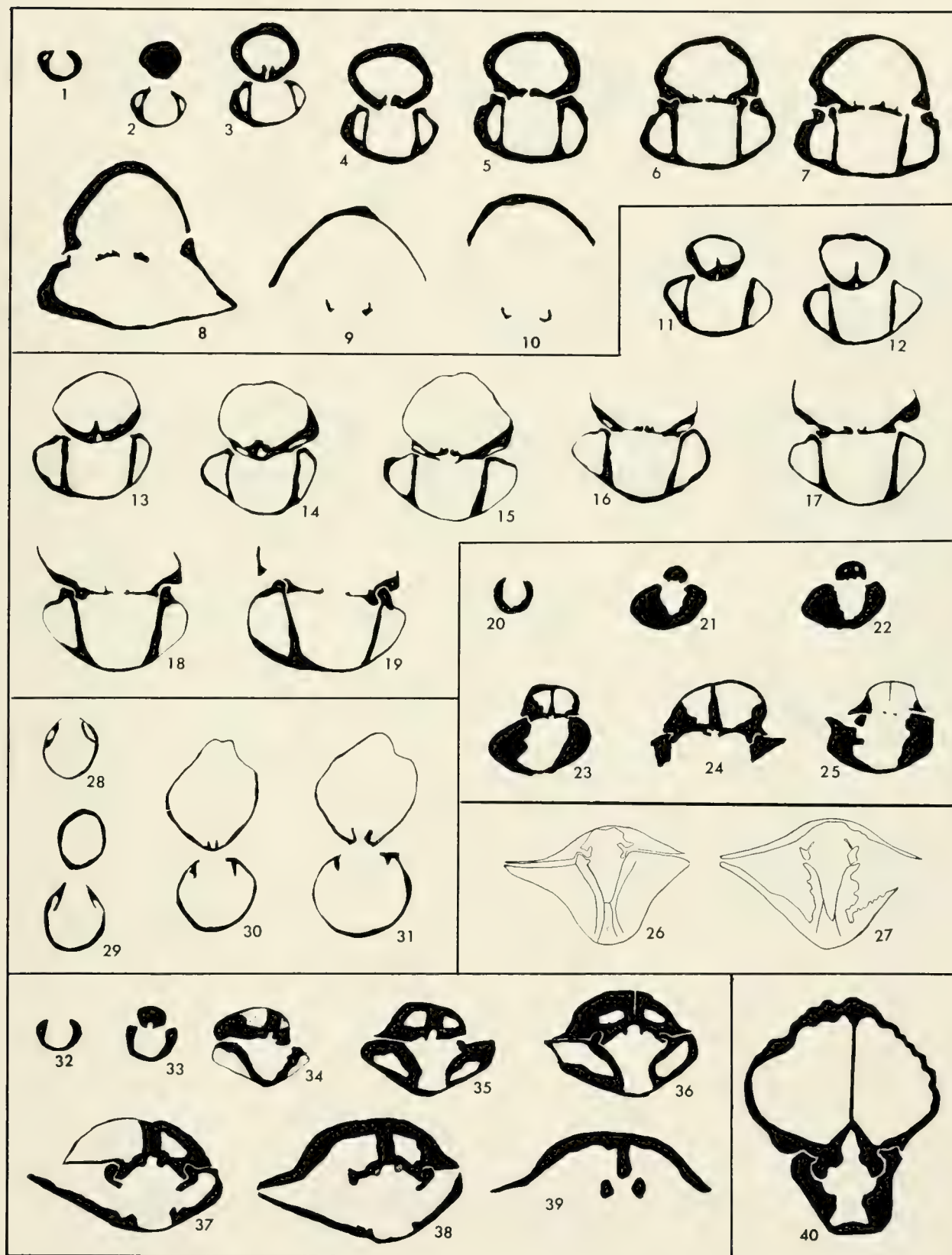


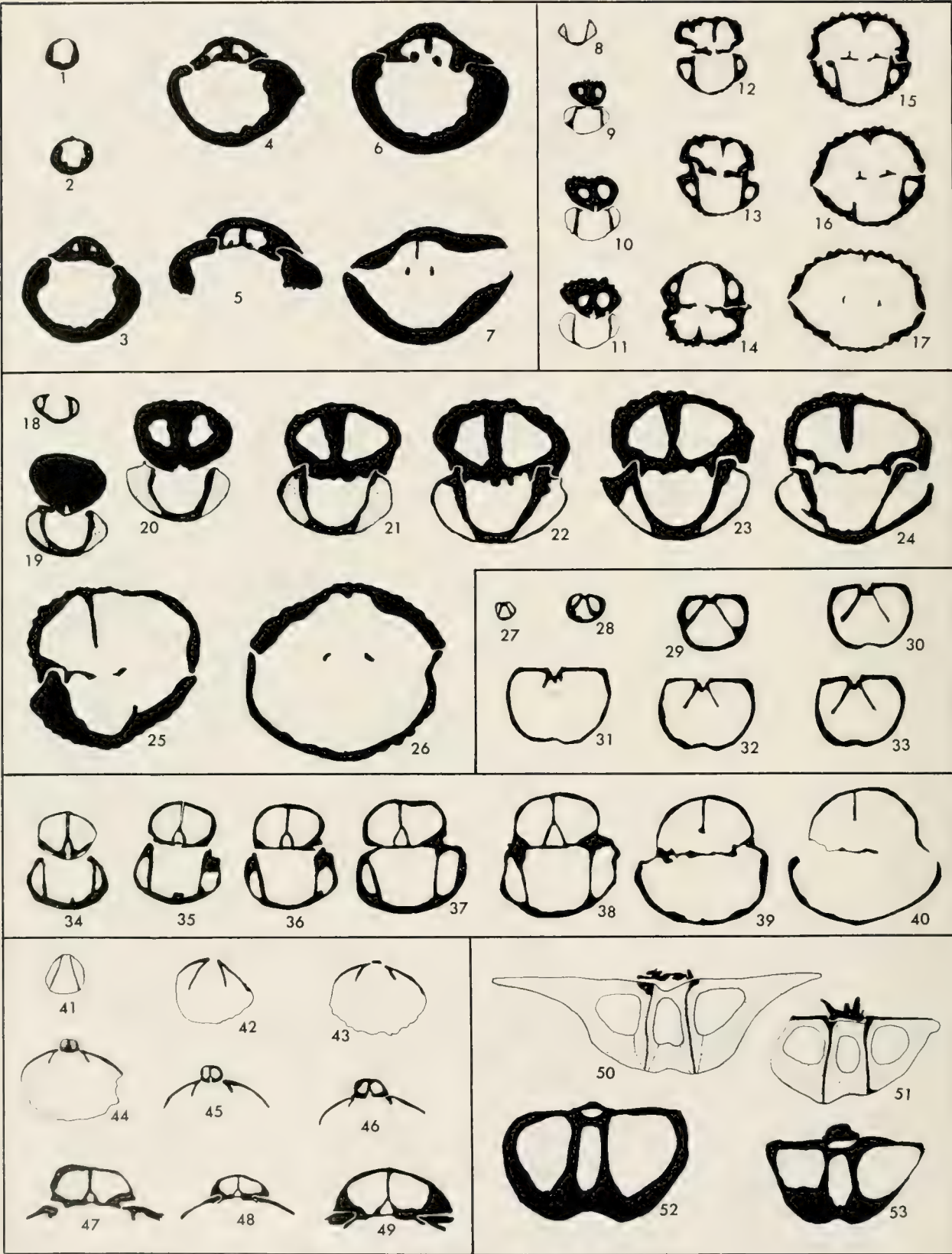
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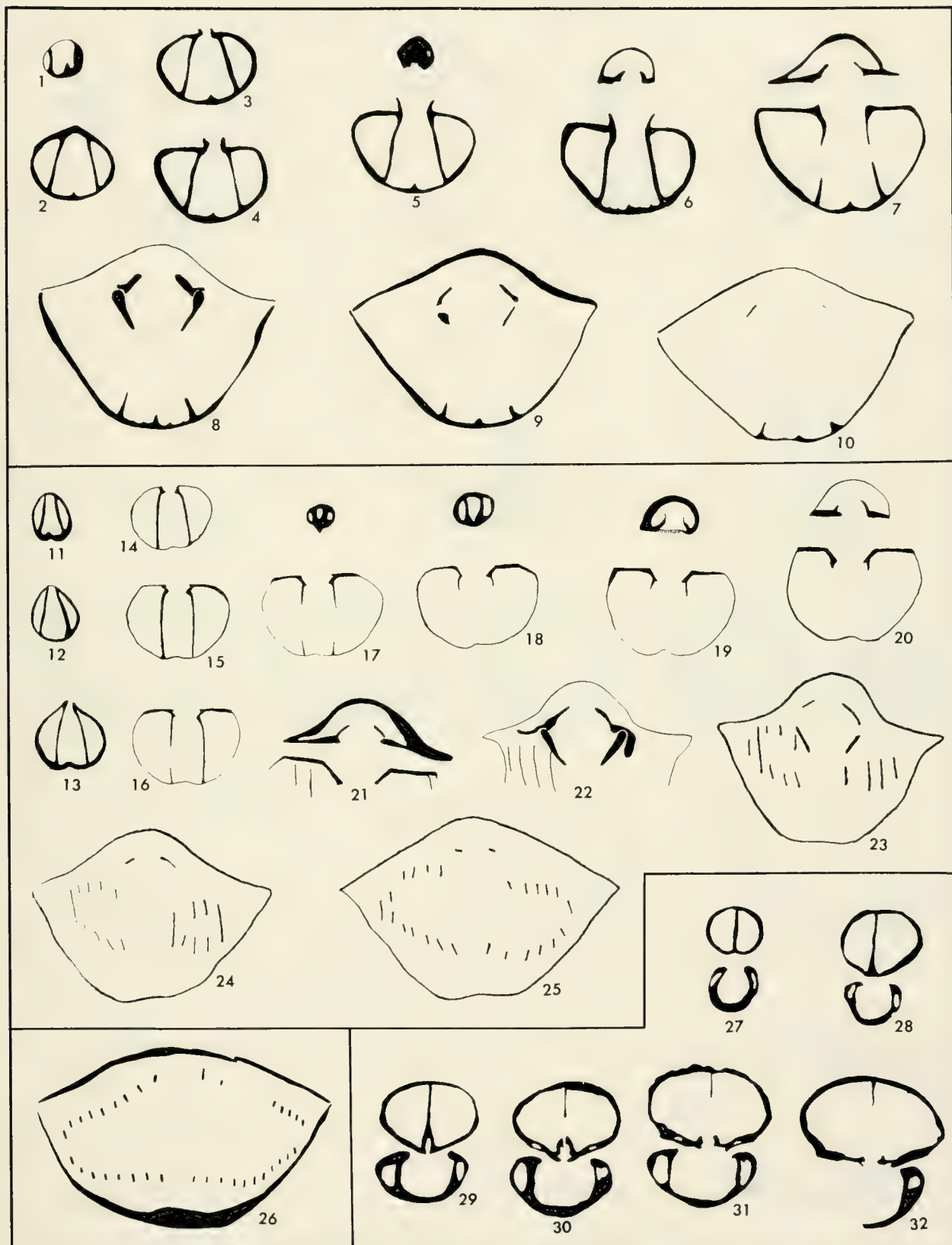
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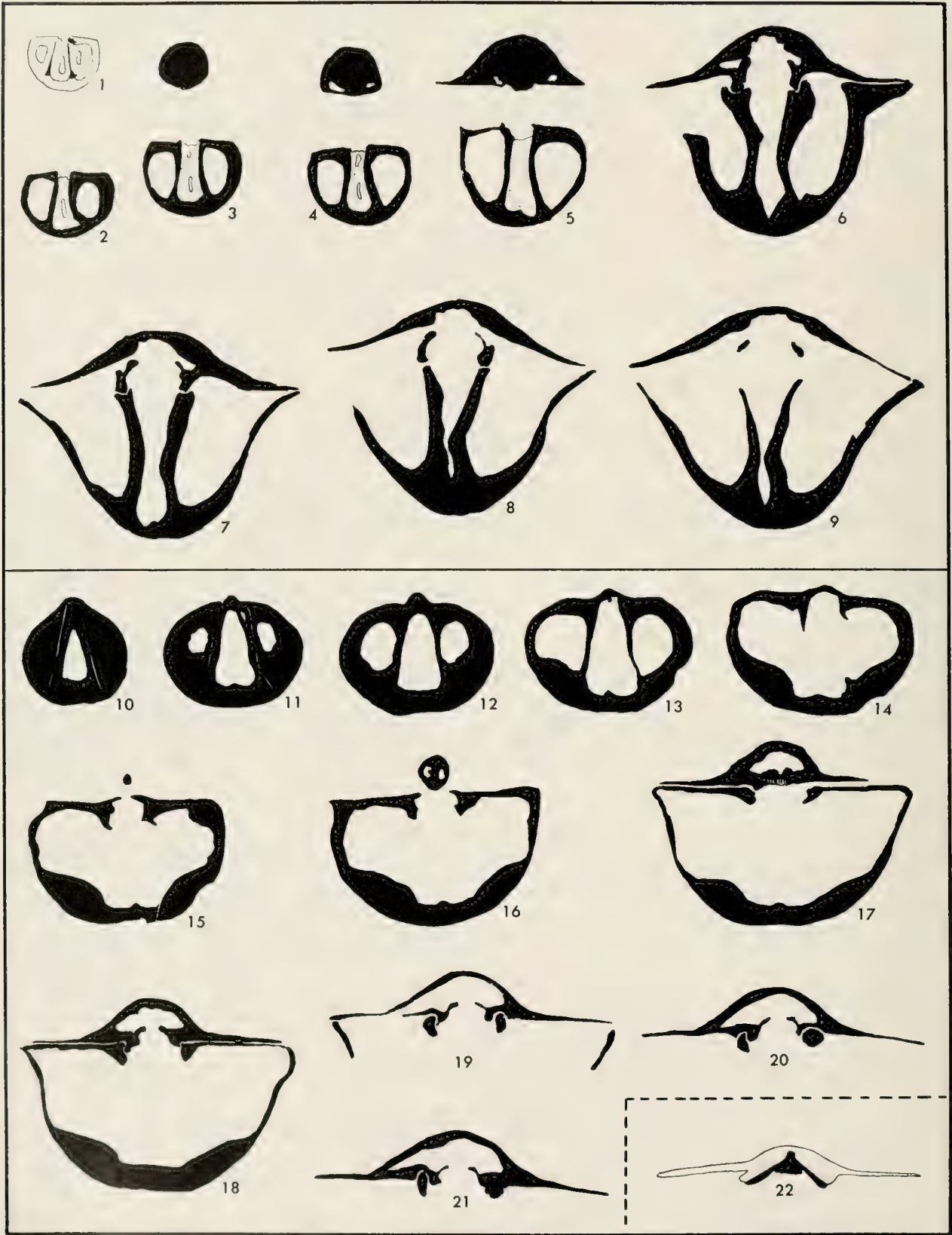
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11-25. <i>Oiosia putilla</i> (Stainbrook).	117
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27-32. <i>Petasmaria patens</i> new species.	85
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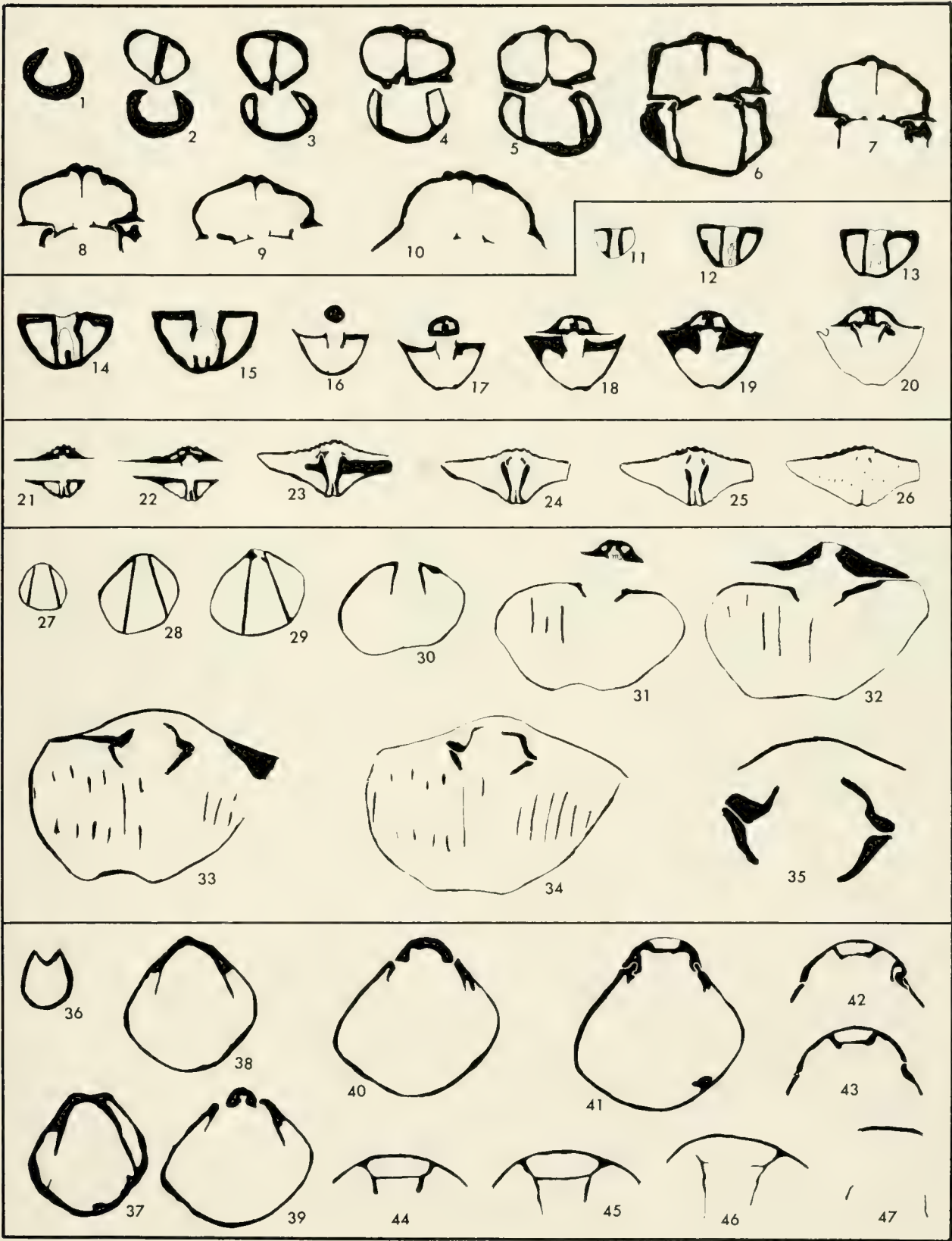
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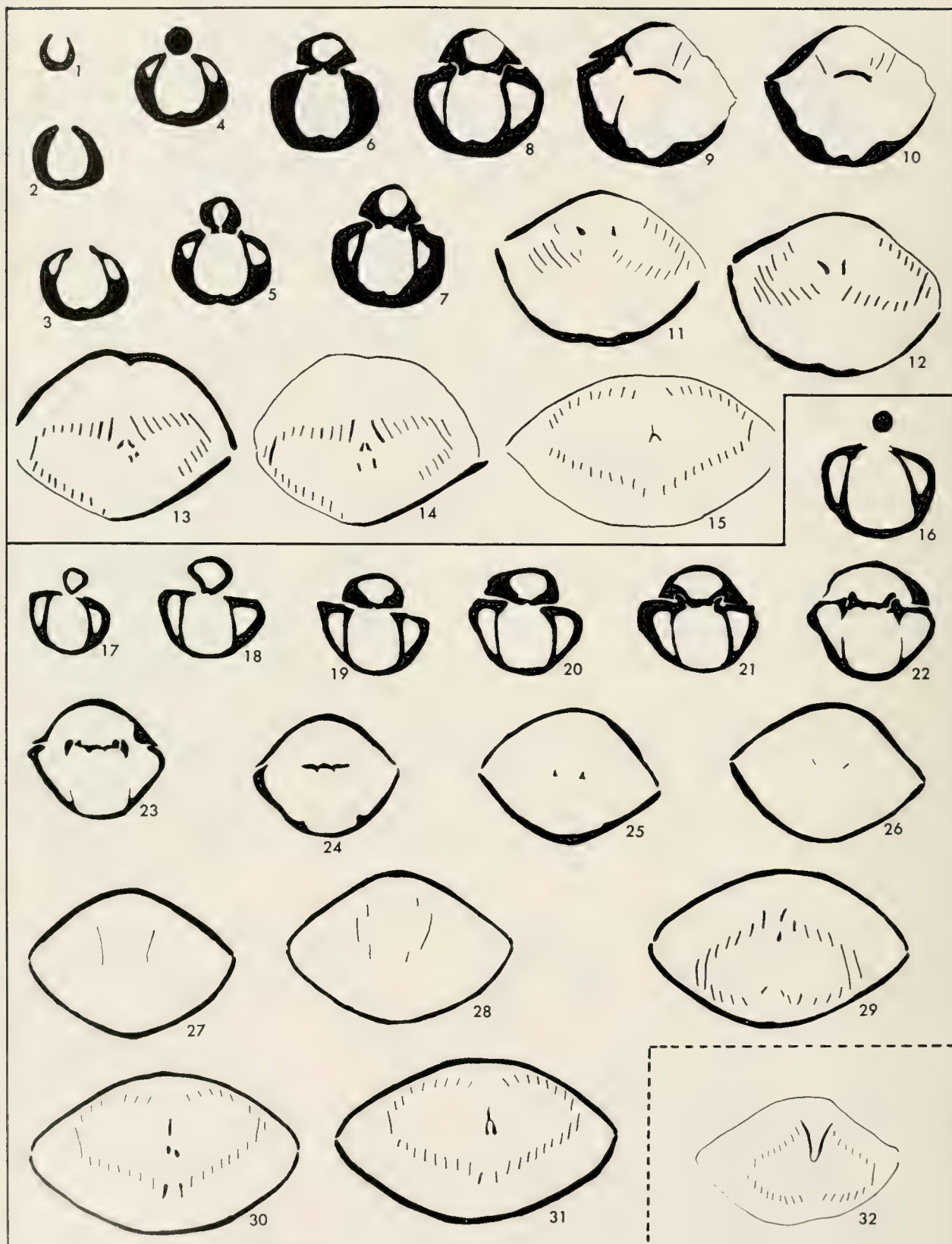
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1-9. <i>Thomasaria warreni</i> new species.	103
Serial sections showing dental plates and cardinalia. Stippling indicates adventitious shell. Distance from beak in mm: 1 = 0.7, 2 = 1.2, 3 = 1.5, 4 = 1.6, 5 = 1.8, 6 = 2.6, 7 = 2.9, 8 = 3.0, 9 = 3.2. 1-5 = $\times 4$; 6-9 = $\times 3$. Paratype USNM 341937.	
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1-10. <i>Petasmaria patens</i> new species.	85
Serial sections showing septa and cardinalia in mm from the beak: 1 = 0.7, 2 = 1.5, 3 = 1.8, 4 = 2.5, 5 = 2.8, 6 = 2.9, 7 = 3.0, 8 = 3.2, 9 = 3.3, 10 = ? [>3.3]. All $\times 3$. Paratype USNM 341940.	
Locality 506b.	
11-20. <i>Acutatheca prolifica</i> new species.	101
Serial sections showing septa and cardinalia in mm from the beak: 11 = 1.0, 12 = 1.5, 13 = 1.8, 14 = 2.0, 15 = 2.3, 16 = 3.1, 17 = 3.4, 18 = 3.8, 19 = 4.0, 20 = 4.4. Figures 11-15 = $\times 3$; figures 16-20 = $\times 1.5$. Paratype 341938.	
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21-26. <i>Tylothyris sulcocostata</i> new species.	98
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36-47. <i>Afilasma inexpectatum</i> new species.	119
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<i>Cyrtina</i>	37,38	Woodward (1852)	34
<i>Douvillinaria</i>	9	<i>wrightorum</i> , <i>Devonalosia</i>	61
<i>Douvillinella</i>	53		
<i>Strophodonta</i>	53	Yochelson, E. L.	31,123,129
<i>variacosta</i> , <i>Atrypa</i>	88		
<i>varicostata</i> ,		Zeller (1965)	8
<i>Atrypa</i>	88	Ziegler (1962)	28
<i>Costatrypa</i>	23	Ziegler and Huddle (1969)	28
<i>varicostatum</i> , <i>Morphorhynchus</i>	15,41	Ziegler <i>et al.</i> (1976)	14
		<i>Zoophycos</i> Massalonge (1855)	23,27

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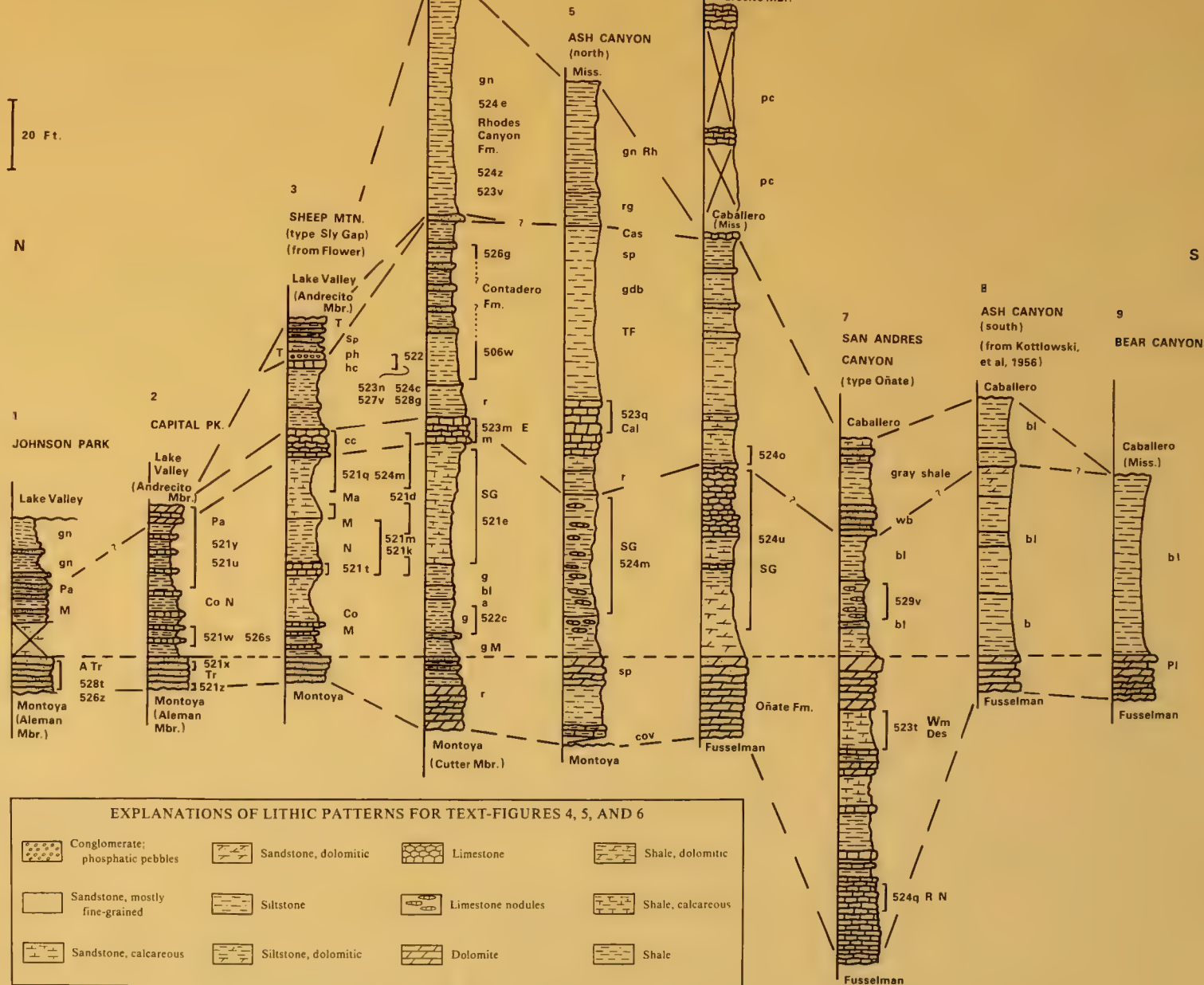
EXPLANATIONS OF ABBREVIATIONS FOR TEXT-FIGURES 4, 5, AND 6 FAUNAL ELEMENTS

- a algae
cc colonial corals
hc horn corals
M *Marceea*
Pa *Pachyphyllum*
br bryozoans
Sph *Sphaerospongia*
lb inarticulate brachiopods
ch chonetids
sp spiriferids
A *Aulacella*
Ac *Acutoria*
At *Atrypa*
Cal large *Camarotoechia*
Cas small *Camarotoechia*
C *Calvinaria*
Co *Costatrypa*
D *Douvillina*
Des *Desquamatia*
E *Elia*
Hb *Hyborhynchella*
Hd *Hadorhynchia*
Hy *Hypothyridina*
N *Nervostrophia*
P *Paurorhyncha*
Pl *Platyerorhynchus*
Pa *Pseudotrypa*
R *Rhyssotoechia*
Rh *Rhipidomella*
S *Syringospira*
Sch *Schizophoria*
St *Striatochonetes*
Th *Thomasaria*
Tr *Tropidoleptus*
Wl *Warrenella floweri*
Wm *Warrenella magna*
SG Sly Gap fauna
TF Three Forks fauna
Ma *Manticoceras*
wbv vertical worm burrows
wgh horizontal worm burrows
f fucoids
cono conodonts
ft fish teeth
- OTHER ABBREVIATIONS
MS mafic sill
cov covered
pc partly covered
ph phosphatic nodules
T Thoroughgood Formation

ROCK MODIFIERS

- bl black
bn brown
cb cobbly
g gray
gb gray-black
gd dark gray
gg gypsiferous
gn green
gnn green with nodules
o olive
r red-weathering
rg red and green

Text-figure 5.—Correlated stratigraphic sections of Devonian rocks, San Andres Mountains, New Mexico. Datum is the top of the Oñate Formation; colonial coral beds in the Sly Gap Formation extend as far south as Rhodes Canyon; T, Thoroughgood Formation, present only from Sheep Mountain to Rhodes Canyon; Rhodes Canyon Formation present only from Rhodes Canyon to Ash Canyon (north). (see Text-figure 3 for location of sections).



PREPARATION OF MANUSCRIPTS

Bulletins of American Paleontology usually comprises two or more separate monographs in two volumes each year. This series is a publication outlet for significant longer paleontological monographs for which high quality photographic illustrations and the large quarto format are a requisite.

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All dated text-citations must be referenced, except those that appear only within long-form synonymies. Additional references may be listed separately if their importance can be demonstrated by a short general comment, or individual annotations. Referenced publication titles must be spelled out in their entirety. Citations of illustrations within the monograph bear initial capitals (*e.g.*, Plate, Text-figure), but citations of illustrations in other articles appear in lower-case letters (*e.g.*, plate, text-figure).

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Authors are requested to enclose \$10 with each manuscript submitted, to cover costs of postage during the review process.

Collinson, J.

1962. *Size of lettering for text-figures*. *Journal of Paleontology*, vol. 36, p. 1402.



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